Mercury Ultratracer UT-3000

Operating Manual

English

Version 2.11

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General information for safe operation

WARNING: While operating the UT-3000 or the Automatic Calibration Unit, parts of its interior are under high voltage. UV-beams are produced inside the instrument. If safety regulations are ignored physical and/or material damages could occur. Only qualified personnel should be authorised to operate the UT-3000 and its accessories.
Conditions for correct function of the UT-3000 system are careful storage and proficient operation and maintenance.

- Do not operate instrument if damaged.
- When connecting the UT-3000 to a power source please note the related safety regulations.
- The UT-3000 or the Automatic Calibration unit should be operated from the type of power source indicated on the rating plate.
- Make sure that plugs and power cord are not damaged.
- Only operate the UT-3000 and its accessories on a stable and dry surface. The interior of the instrument should never get moist or wet. In case it happens, consult an expert.
- Regulations for prevention of accidents are to be followed.
- Before opening the UT-3000 or the calibration device disconnect it from its mains supply.
- Repair and maintenance on the opened and powered instrument must only be done by qualified personnel.
- The UT-3000 is dedicated for the measurement of mercury concentrations in air and gaseous samples. Do obey the related dangers while working with toxic or harmful substances. Do not operate the UT-3000 in hazardous areas or for measurement of flammable or explosive gases. A special version for mercury measurement in natural gas is available. This must be explicitly indicated on the instrument and in the according documentation which comes

with the instrument. The instructions provided in the operation manual have strictly to be followed.

- The calibration device (Automatic Calibration Unit and Manual Calibration Unit) contains elemental mercury. Damage which may lead to a leakage has strictly to be avoided. Calibration device must only be opened and/or repaired by qualified and specially trained persons. Calibration device has to be protected from shocks and must never be tilt or turned over. Notify also the Material Safety Data Sheet in the appendix.

Contents

GENERAL INFORMATION FOR SAFE OPERATION 2

1. GENERAL DESCRIPTION 7

1.1 APPLICATIONS 7
1.2 MEASURING PRINCIPLE 9

2. INSTALLATION 10

2.1 PREPARATION FOR OPERATION 10
2.2 ELECTRICAL POWER SUPPLY 11
2.3 OPERATION AND DISPLAY COMPONENTS 11
2.4 CONNECTION OF THE ELECTRICAL OUTPUT 11
2.4.1 Serial Data output (USB / RS 232) 11
2.4.2 Connection of an Automatic Calibration Unit 14

3. OPERATING INSTRUCTIONS 15

3.1 TURNING ON THE UT-3000 15
3.2 MAIN MENU 15
3.3 BASIC SETTINGS 17
3.4 SET SAMPLE PARAMETERS 17
3.4.1 Set Sample Volume 17
3.4.2 Set Cycle Duration 18
3.4.3 Auto Range Volume (only for Natural Gas / Tedlar Bag Version) 19
3.5 START MEASURING 19
3.6 DATA LOGGER 21
3.6.1 Start logging of measurement data 21
3.6.2 Sending logged data to a PC by using Hyper terminal 22
3.6.3 Delete logged data 24
3.6.4 Import of data into EXCEL 24
3.6.5. Using the HG-Transfer Software for Data Transfer to a PC 26

4. CALIBRATION 29

4.1 SHOW ACTUAL CALIBRATION 29
4.2 SHOW ALL CALIBRATIONS 30
4.3 PERFORM SPAN CHECK 31
4.4 PERFORM NEW CALIBRATION: MANUAL CALIBRATION 31
4.4.1 Manual Calibration: Enter pg 32
4.4.2 Manual Calibration: Enter µl 36
4.4.3 Examples for calibration functions 40
4.5 PERFORM NEW CALIBRATION: AUTOMATIC CALIBRATION (OPTION) 43
4.5.1 Connecting the Automatic Calibration Unit with the UT-3000 43
4.5.2 Activating the Automatic Calibration Function 44
4.5.3 Cal. Concentration 45
4.5.4 Cal. Interval 45
4.5.5 Manual Start of the Automatic Calibration 46
4.5.6 Automatic Start of the Calibration 47
4.5.7 Empty Syringe 48
4.5.8 Cal. Mode 48
4.5.9 Activation of Automatic Span Calibration 48

5. SERVICE-MENU 49

5.1 SET DATE AND TIME 50

5.2 DEVICE DATA 50
5.3 SHOW FLOW 50
5.4 PURGE REPETITIONS (FOR AUTOMATIC CALIBRATION OPTION ONLY) 50
5.5 CHANGE SYRINGE (FOR AUTOMATIC CALIBRATION OPTION ONLY) 51
5.6 SET CALIBRATION DATA 51
5.6.1 Set Flow Calibration *51*
5.6.2 Set Measuring Calibration *52*
5.6.3 Set T-Cal. Cell Calibration *52*
5.7 TRAP COUNTER 52
5.8 SET RS232 MODE 52
5.9 SET ZERO DURATION 52
5.10 SET STATUS 53
5.11 SPECIAL SERVICE CODES 54

6. MAINTENANCE **55**

6.1 SPARES AND ACCESSORIES 55
6.2 TECHNICAL DRAWINGS 57
6.3 ERROR MESSAGES 64
6.3.1 Lamp ! *64*
6.3.2 Sampling Flow out of Range! *64*
6.3.3 Heating Flow out of Range! *64*
6.3.4 Temp. out of range ! See instruction manual! *64*
6.3.5 Check heating coil ! *64*
6.3.6 T-Sensor not connected ! Connect T-Sensor of Calibration Cell! *64*
6.3.7 Temp out of Range ! See instruction manual! *65*
6.3.8 Pump ! (flashing) *65*
6.3.9 Lamp Stability! *65*
6.3.10 Logger full (flashing) *65*
6.3.11 No Sample!!! *65*
6.3.12 EEP INIT; Warning No. 20: Check Parameters! See Instruction Manual! *65*
6.3.13 Warning No. 50: Check Calibration! See Instruction Manual! *65*
6.3.14 Warning No. 60: Check Flow-Calibration ! See Instruction Manual! *65*
6.3.15 Warning No. 70; Check Calibration Data! *66*
6.3.16 Warning No. 80; RS232 Communication Error; Connect Syringe! *66*
6.3.17 Warning No. 91; Check Calibration! *66*
6.3.18 Repeat Zero *66*
6.3.19 Low Sampling Flow *66*
6.4 TROUBLESHOOTING 67
6.4.1 Unusual Measuring Peaks *67*
6.5 ROUTINE MAINTENANCE 68
6.5.1 Replacement of Membrane Filter *68*
6.5.2 Replacement of the filter cartridges *68*
6.6 FUSES 70
6.7 CLEANING THE GOLDTRAP 71
6.8 REPLACEMENT OF THE GOLDTRAP 73
6.9 FLOW ADJUSTMENT (FOR QUALIFIED PERSONNEL ONLY) 75
6.9.1 Heating Flow Adjustment *75*
6.9.2 Sampling Flow Adjustment *75*
6.10 GOLD TRAP ASSEMBLY 76

7. TECHNICAL INFORMATION **78**

7.1 TECHNICAL SPECIFICATIONS 78
7.2 INFLUENCING EFFECTS 78
7.3 STORAGE AND TRANSPORT 79

8. VERSION FOR HG DETERMINATION IN NATURAL GAS AND OTHER HYDROCARBON GASES (TEDLAR® BAG VERSION) 80

8.1 SAMPLING SYSTEM FOR MERCURY DETERMINATION IN NATURAL GAS 80
8.2 SETUP FOR CONTINUOUS MEASUREMENT OF HG IN NATURAL GAS 83
8.3 UT-3000 VERSION FOR ANALYSIS USING A SAMPLE BAG (TEDLAR® BAG) 84
8.3.1 Setup of the UT-3000 analyzer 85
8.3.2 Sampling of natural gas with the sample bag (Tedlar® bag) 86
8.3.3 Measuring the sample from the bag 86
8.4 SELECT PUMP TYPE 90

9. COMMUNICATION WITH EXTERNAL DATA ACQUISITION SYSTEM (OPTION) 91

9.1 PARAMETER SETTINGS FOR REMOTELY TRIGGERED ZERO AND SPAN CHECK 91
9.2 UT- 3000 EXTERNAL DATA ACCESS *(VERSION 04.05.2004)* 91

APPENDIX 97

EC-DECLARATION OF CONFORMITY 97

1. General Description

1.1 Applications

The UT-3000 is dedicated for automatic measurement of mercury concentrations in air and other gaseous samples.

- The mercury Ultratracer provides a compact and reliable tool for automatic measuring of Total Gaseous Mercury (TGM) in air at ultratrace levels. Utilising the high performance GoldTrap amalgamation module and the optimised state-of-the-art Atomic Absorption detector detection limits at sub-ng/m³ levels are achieved.
- The instrument operates automatically, all functions are controlled by an embedded microprocessor. Once the analysis has been started, measurements are performed automatically and data are collected by the built-in data logger. The capacity of the data logger is up to 100 days.
- The UT-3000 is used in following applications:
- Air quality studies
- Monitoring of indoor air pollution
- Environmental pollution source tracking
- plume profiling
- Studies of mercury dispersion in the atmosphere
- Studies of interaction between atmosphere and surfaces
- Pollution prevention
- Natural gas and derivatives (observe special hazardous zone requirements)
- Hydrogen and other gases (observe special hazardous zone requirements)
- Soil and ground degassing studies

FIGURES: THE UT-3000 ULTRATRACER IN THE FIELD - A VERSATILE INSTRUMENT FOR MONITORING MERCURY IN AIR AND GASES AT ULTRA TRACE LEVELS

FIGURE: FORMATION OF SMOG IN A CITY (KUALA LUMPUR)

FIGURE: THE UT-3000 IN OPERATION: MONITORING OF URBAN AIR QUALITY (MUNICH).

FIGURE: PIPELINE FOR NATURAL GAS (RUSSIA)

FIGURE: ANALYSIS OF MERCURY IN NATURAL GAS USING THE UT-3000 WITH THE TEDLAR BAG TECHNIQUE

FIGURE: MEASUREMENT OF MERCURY IN NATURAL GAS (EGYPT)

1.2 Measuring principle

The UT-3000 uses the Mercury Instruments GoldTrap to capture total gaseous mercury (TGM) directly from the sample. GoldTraps work because mercury sticks to gold at room temperature. The sample gas is pulled through a 0.45 micron PTFE filter and then passes the trap. The gas continues to flow through the trap but the mercury stays behind--trapped on the gold. After the mercury is captured, the GoldTrap is heated very quickly; this releases the mercury as a gas (thermal desorption). The gaseous mercury is then swept by the flow of purified mercury free air into the optical cell of the detector. Here the mercury is measured by atomic absorption spectrometry (AAS).
Basis for determination of the mercury concentration by AAS is the resonance absorption of the Hg-atoms at a wavelength of 253.7 nm. The sample gas is carried into the optical cell by a built-in pump. The optical cell is entirely made of synthetic quartz glass. Radiation of a mercury lamp passes through the cell and is measured by a solid state detector. The attenuation of the UV light reaching the detector depends on the number of mercury atoms in the optical cell. The microprocessor performs the quantitative evaluation of the mercury concentration in the sample. In order to get an extremely stable baseline, the UV-light source is controlled by a reference beam and reference detector device. In addition to this, the UV detectors of the UT-3000 are thermostatically controlled. Heating the optical cell and the GoldTrap makes the UT-3000 insensitive to volatiles like water vapor and hydrocarbons.

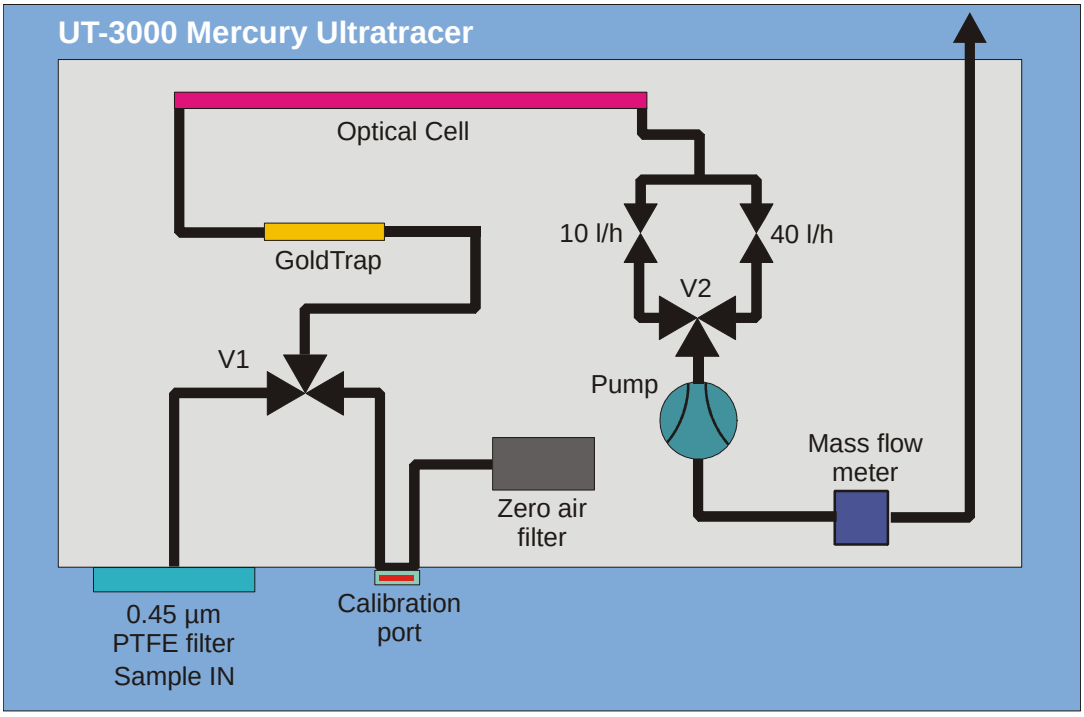


FIGURE: UT-3000: SCHEMATIC GAS FLOW

2. Installation

2.1 Preparation for Operation

The UT-3000 is unpacked and placed on a flat surface (e.g. table). The handle can be adjusted in several steps in order to be used for carrying the instrument or as a base to position it on a bench (only if applicable; there is also a version for 19" rack mount available).

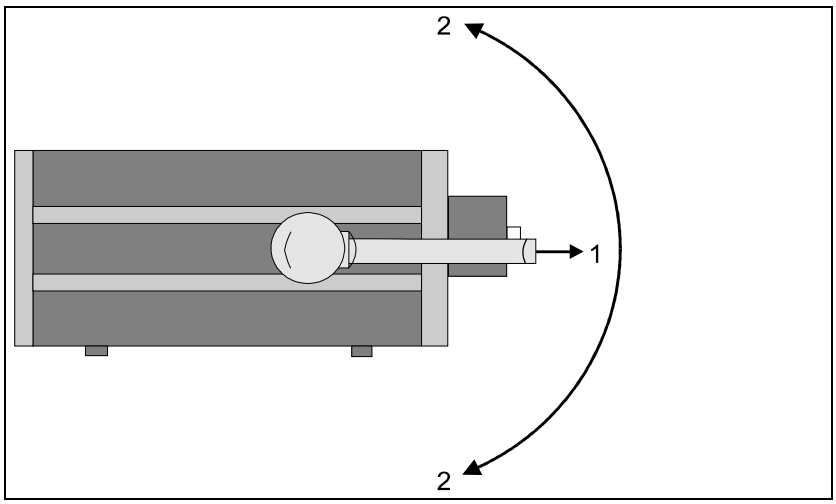
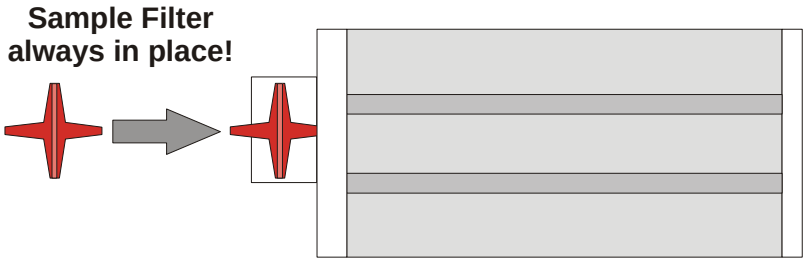


FIGURE: ADJUSTMENT OF CARRYING HANDLE

The sample inlet filter (0.45 µm PTFE) is unpacked. Insert the filter into the filter holder on the front panel of the instrument and push it carefully over the white nozzle in the center of the filter holder. Turn the filter slightly to get a tight connection.

☞ **The printed side of the filter shows towards the operator.**

Never operate the instrument without a sample inlet filter installed !



2.2 Electrical power supply

The voltage of the power source has to be the same as the operation voltage indicated on the rating plate of the UT-3000. One end of the included power cord has to be connected to the power cord receptable on the back of the UT-3000. The opposite end has to be plugged into an appropriate power outlet. For operation turn on the UT-3000 by pushing the power switch on the back plate to position I.

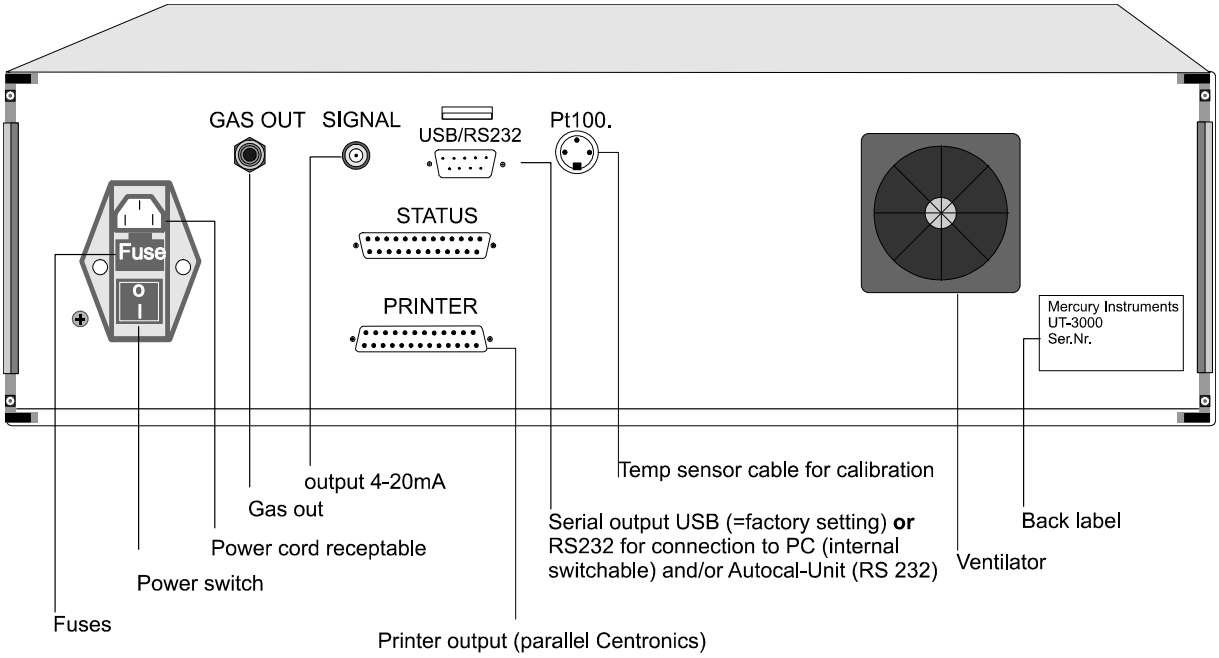


FIGURE: REAR PANEL OF UT-3000

2.3 Operation and display components

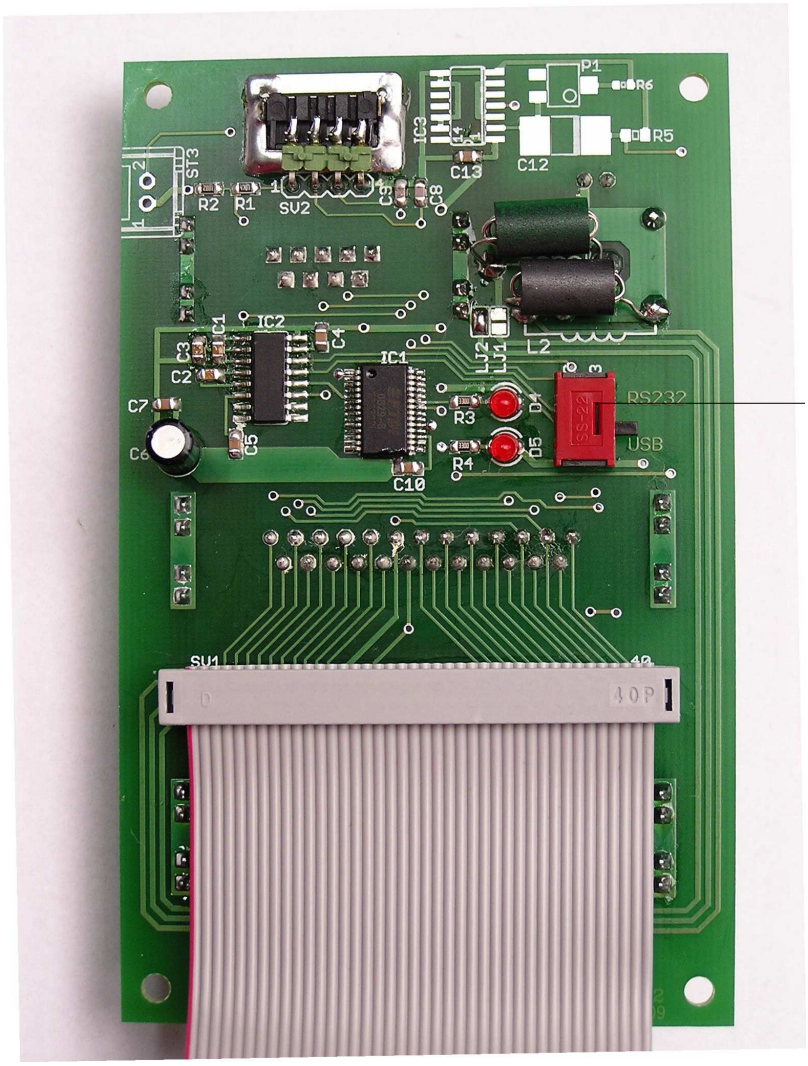
The UT-3000 features a waterproof IP66 keypad and a graphic LCD with background illumination for comfortable operation.

2.4 Connection of the electrical output

2.4.1 Serial Data output (USB / RS 232)

To read out data from the built-in data logger or measurement results in realtime connect the UT-3000 with a PC. The serial input of the PC (COM1 or COM2) has to be connected to the USB-port on the rear panel of the instrument using an appropriate cable (part no. 202-07a). Below the USB-port there is also available a 9-pin DSUB-socket labelled “RS232”. This socket is normally used for the controlling of the automatic calibration device option. But by manually switching an

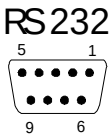
internal dipswitch on the backplane (see picture below) you can use this RS232-socket instead of the USB with an appropriate 1:1 cable (part-no. 202-07) for the output of measuring values.



Dip-switch to choose either Rs232 or USB-connection -

standard = USB

FIGURE: BACKPLANE WITH DIPSWITCH BETWEEN USB (FACTORY SETTING) AND RS232



Pin Nr.	5	3	2
	GND	RxD	TxD

FIGURE: SERIAL RS232 OUTPUT SOCKET ON INSTRUMENTS REAR SIDE

Data are transferred as ASCII-characters every time a measurement cycle has been completed. They can be received and filed on the PC using a terminal program, for example Windows Hyper Terminal.

The parameters for data transfer are:

9600 Baud / 8 Data bits/ 1 Stop bit/ no Parity and Xon/ Xoff.

The data set has following format:

Date Time Status Volume Reading [CR][LF]

One data set has 34 bytes, end is carriage return and line feed.
Following Status Codes are possible:

Code	Meaning
MS	Measuring
LA	Lamp Error
SF	Sampling Flow out of range
HF	Heating Flow out of range
HC	Check Heating Coil
PU	Pump failure
CD	Check Calibration Data
CP	Check Calibration
LS	Lamp Stability
NS	No Sample
WC	Wrong Calibration

Example for data sets:

09.03.07 10:22 MS 001.0 000006.0
09.03.07 10:26 MS 001.0 000006.0
09.03.07 10:30 MS 001.0 000006.0
09.03.07 10:34 MS 001.0 000006.0
09.03.07 10:38 MS 001.0 000006.2
09.03.07 10:42 MS 001.0 000006.1
09.03.07 10:46 MS 001.0 000005.9

A description of the status messages is given in chapter 7.2.
For readout of measuring data stored in the data logger see chapter 3.6.

2.4.2 Connection of an Automatic Calibration Unit

> ☞ **If an Automatic Calibration Unit is installed together with the UT-3000, both instruments have to be connected before starting operation.**

a) Use the connecting cable which has two 4-pin round plugs and plug it into the sockets on the rear side of the instruments marked "**Temperature**" and "**PT100**".

b) Take the cable with the 9-pin DSUB plugs. Identify the plug labelled "UT-3000" and connect it to the RS232 socket on the rear side of the UT-3000. Identify the plug labelled "Calibration unit" and connect it to the RS232 socket on the rear side of the Automatic Calibration Unit.

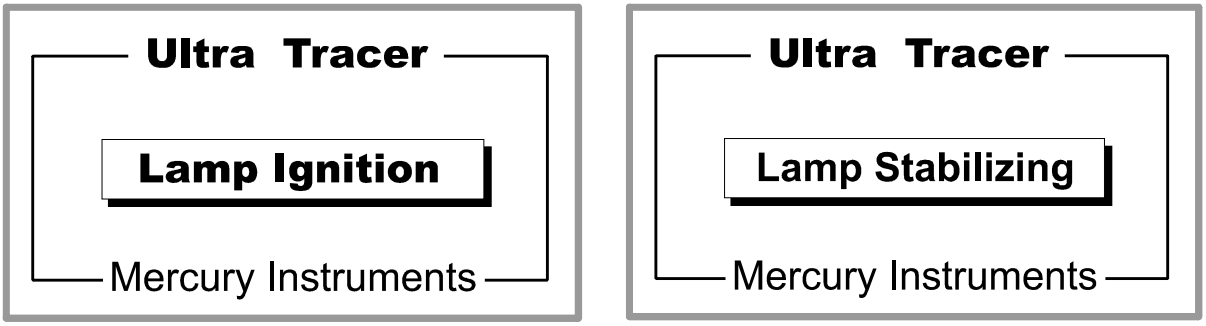
FIGURE: BACK SIDE OF UT-3000 (UPPER) AND AUTOMATIC CALIBRATION UNIT (LOWER) WITH CONNECTION TUBING, PT100-CABLE AND RS232-CABLE

3. Operating instructions

3.1 Turning on the UT-3000

Do not operate the UT-3000 without the sample inlet filter installed in place. If this precaution is ignored, the system, especially the GoldTrap, may be damaged by dust particulate.
The UT-3000 version for use with an Automatic Calibration Unit must not be operated without the connecting tubing of the Automatic Calibration Unit connected to the UT-3000 (see chapter 4.2.1).

After turning on the UT-3000 the mercury lamp ignites and heats to operation temperature. Following indications will appear on the display first:



In case of using an automatic calibration device (which has to be connected and switched on before, see chapter 4.3.2), there will be an initiation step of the syringe after lamp stabilizing phase (**INIT SYRINGE**).

3.2 Main Menu

After the instrument has stabilized, which typically takes 5-15 minutes (depending on the ambient temperature), following steps will be performed automatically:

Zeroing - Trap Cleaning - Trap Cooling - Zeroing - Trap Cleaning - Trap Cooling - Zeroing - System Evaluation - Trap Cooling - Sampling ...

The Main Menu can be entered by pressing the ***ESC***-key during Sampling.
By simply pressing the numbered keys shown on the Main Menu the desired function can be chosen.

For the Tedlar bag version a different main menu is displayed. In this case some of the other menus may also differ, see chapter 6.4.

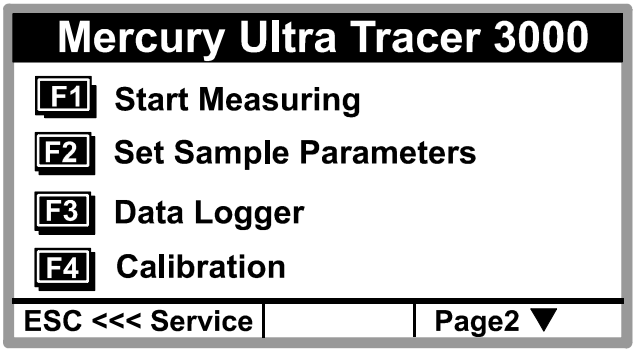


FIGURE: MAIN MENU

Following functions can be selected from the main menu:

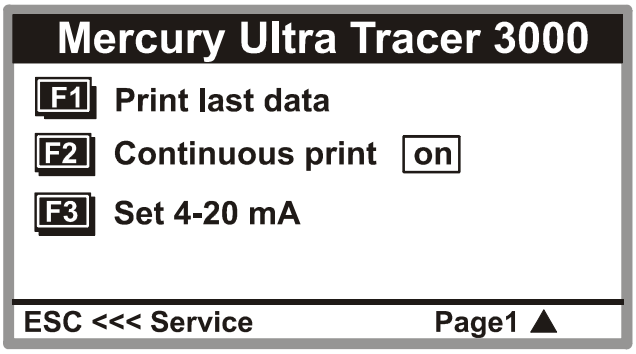
F1: Start Measuring = measurement cycle starts with automatic sampling, followed by gold trap heating and atomic absorption measurement.

F2: Set Sample Parameters = set sample volume or measurement cycle duration.

F3: Data Logger = data logger management: switch on/off data logger, display logged data, transfer logged data to PC, clear logged data.

F4: Calibration = show actual or all calibrations or perform new calibration or span check.

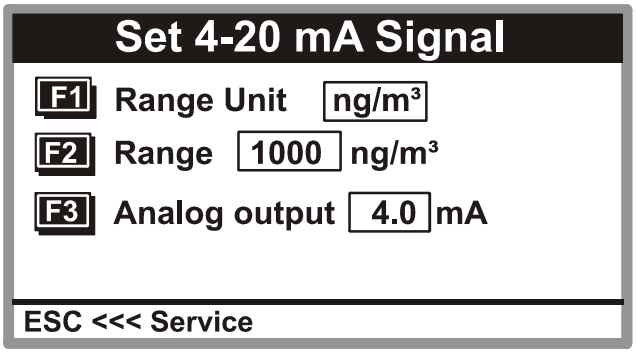
Page2▼ = show next page



F1: Print last data: all data (up to 200 measurements) since the last sample volume setting are printed. For this function a printer must be connected to the parallel printer output.

F2: Continuous print on/off: results are printed automatically if a measurement is completed. For this function a printer must be connected to the parallel printer output.

F3: Set 4-20 mA: F1- allows setting of measuring unit µg/m³ - ng/m³; F2- setting of the measuring range relevant for the 4-20 mA signal. F3- the 4-20 mA output can be tested, the output signal will be according to the set mA value..



3.3 Basic Settings

☞ For the first measurement settings in the **Service Menu** have to be made.

Press **ESC-Service** in the main menu to go to the service menu.

Now you have to enter a service code. Follow the instructions given in chapter 5 in order to perform the required settings.

3.4 Set Sample Parameters

3.4.1 Set Sample Volume

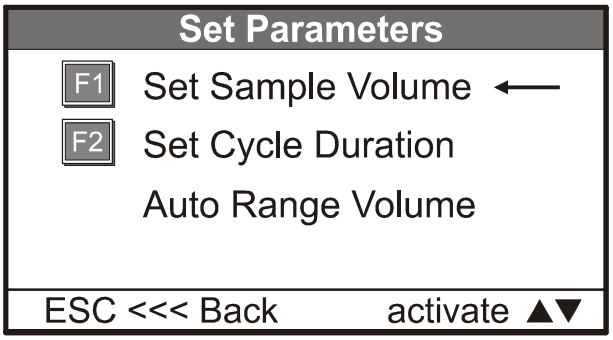
Press **F2-Set Sample Parameters** in the main menu and activate "Set sample volume" by moving the arrow to the corresponding line. Then press **F1** and enter the desired sample volume. Characters can be deleted with the ◀ -key. The according sampling time is automatically calculated and displayed.

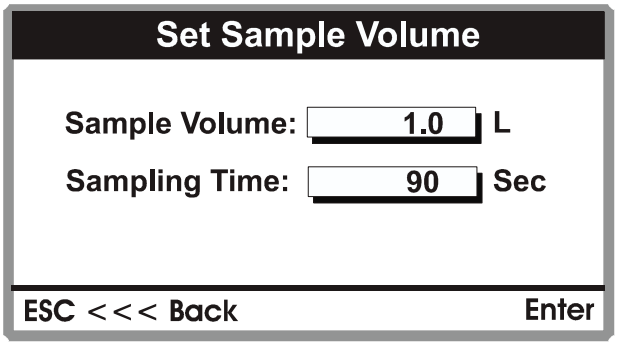
a) For fast screening measurements (accuracy >1 ng/m³) a sample volume of **1 l** is recommended.

b) To achieve better sensitivity and optimum analysis speed (accuracy ~0.2 ng/m³) a sample volume of **10 l** is recommended.

c) For a maximum sensitivity (accuracy ~0.1 ng/m³) a sample volume of **20 l** or more can be set.

☞ **Note:** The sample volume determines the sampling duration. As a constant flow rate of 0.67 l/min is applied during sampling, a 1 l sample volume gives a sampling duration of ca. 90 seconds (a 10 l sample gives a sampling duration of ca. 15 minutes respectively).

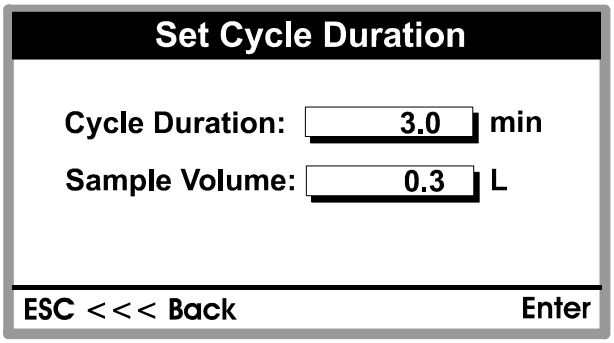




3.4.2 Set Cycle Duration

Press **F2-Set Sample Parameters** in the main menu and activate "Set Cycle Duration" by moving the arrow to the corresponding line. Then press **F2** and enter the desired cycle duration. Characters can be deleted with the ◄ - key. The according sample volume is automatically calculated and displayed.

☞ The Cycle Duration is the total time needed for a complete measuring cycle, that means: Sampling Duration, Zeroing, Heating, Trap Cooling, Trap Cleaning, …



3.4.3 Auto Range Volume (only for Natural Gas / Tedlar Bag Version)

If **Auto Range** is activated the sample volume will be automatically adjusted according to the mercury concentration of the sample. After Start Measuring the smallest possible sample volume is selected automatically. If the absorbance signal is low, the sample volume will be increased after each measurement until the absorbance is within the optimum range.

3.5 Start Measuring

Press in the Main Menu **F1-Start Measuring**. Now the analyzer automatically performs a cleaning procedure and then starts sampling. After sampling is completed following steps will be performed:

zeroing - trap heating - trap cooling – trap cleaning – trap cooling - sampling.

If the first measurement cycle has been completed, the system performs automatically the next measurement cycle unless ESC is pressed or the instrument is switched off.
The result of the last measurement is displayed numerically at the centre of the bottom line, up to 5000 measurement results are displayed as bar graph. The time axis of the screen can be scrolled with the F3 and F4 keys.

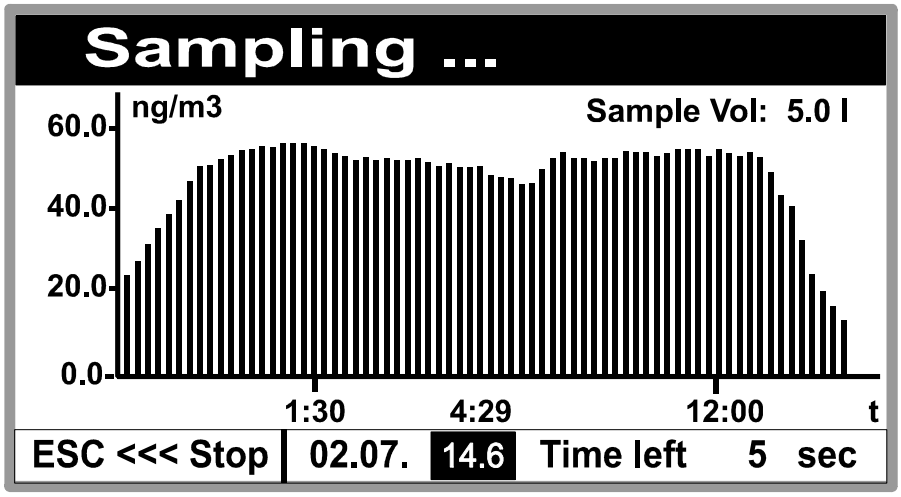


FIGURE: SCREEN DURING SAMPLING. THE HISTORY OF READINGS IS DISPLAYED AS A BAR GRAPH. THE RESULT OF THE LAST MEASUREMENT IS DISPLAYED IN A BOX ON THE BOTTOM LINE.

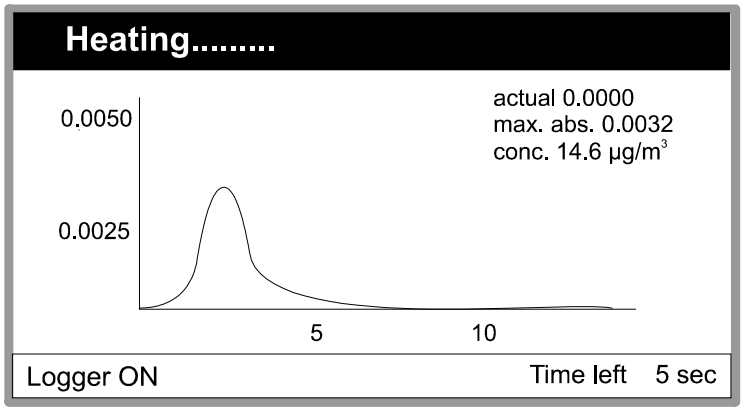


FIGURE: SIGNAL PEAK DURING THERMAL DESORPTION OF THE GOLDTRAP.

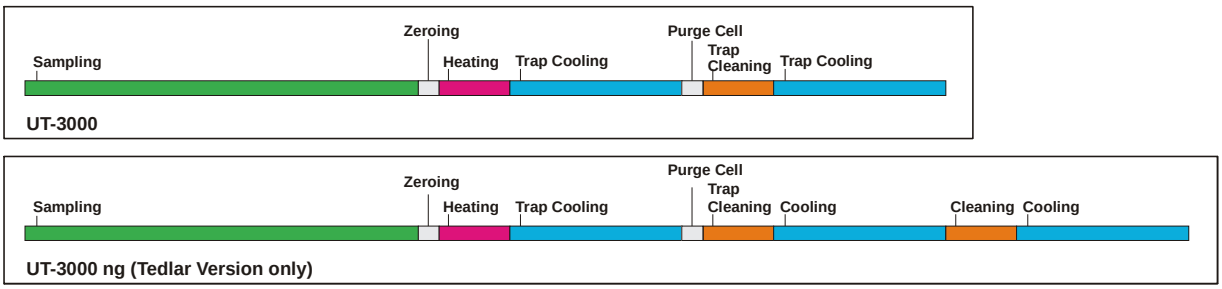


FIGURE: UT-3000: MEASUREMENT CYCLE

Sampling	Zeroing	Heating / Cleaning	Cooling
5 s to 15 min; depending on sample volume	11 s	20 s	45 s for sample vol. 1 L and up >45 s for sample vol < 1 l

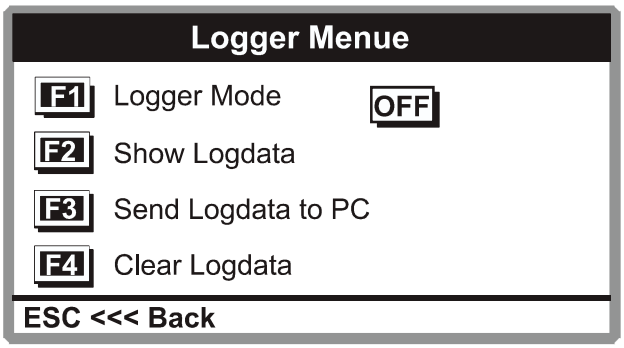
TABLE: DURATIONS OF THE ANALYSIS STEPS

Repeat Zero: Zeroing is repeated up to 10 times if the heating flow is out of range (7 l/h < heating flow <13 l/h)

3.6 Data Logger

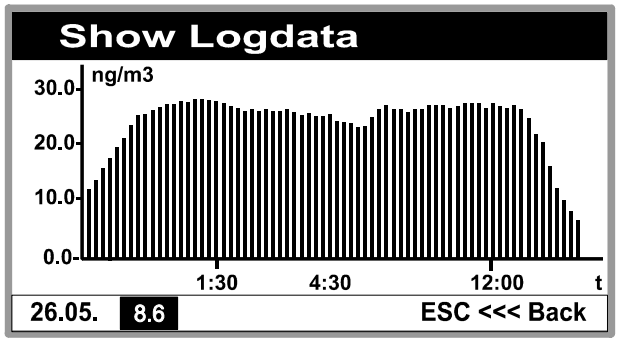
The internal data logger of the UT-3000 can store data of up to 5000 measurements. The maximum logging duration depends on the set sample volume, for a sample volume of 10 l the logging capacity will be approximately 60 days.

If **F3- Data Logger** is selected in the main menu, the **Logger Menu** is displayed.



F1- Logger Mode: the logger function can be switched on or off.

F2- Show Logdata: the logged readings are displayed as a bar graph. The graph can be scrolled with the **F3** and **F4** keys.



F3- Send Logdata to PC: If a PC is connected to the RS232 output of the Ultratracer and a data transfer program (e.g. Hyper Terminal) has been started, data are sent to the PC after pressing the **F3** key (see chapter 3.6.2).

F4- Clear Logdata: the logged and stored data are erased.

3.6.1 Start logging of measurement data

After the data logger has been activated the measurement data are automatically logged whenever the measurement mode is active. The status of the logger is indicated on the display (F1- Logger Mode ON/OFF).

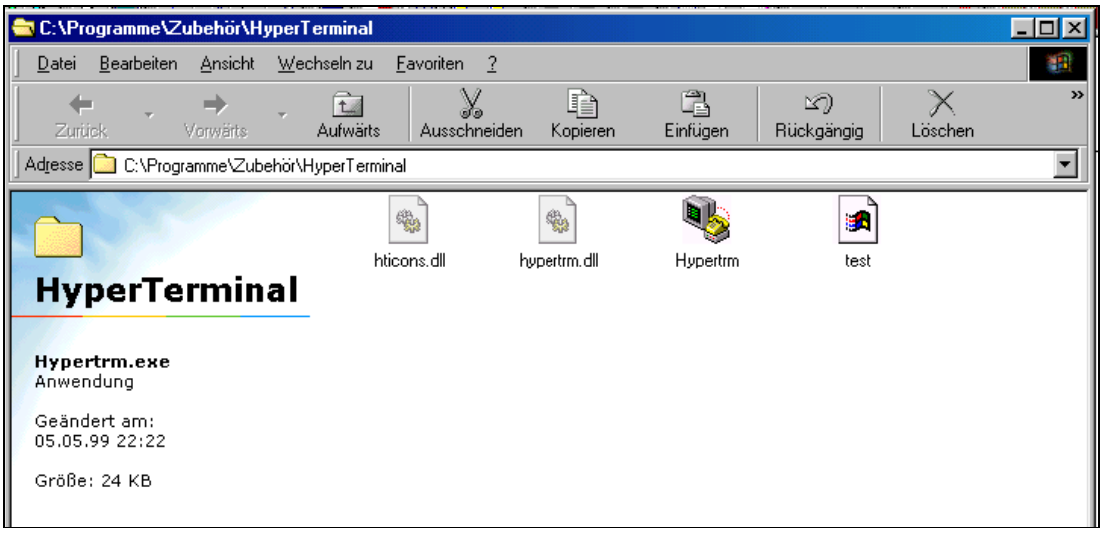
For transferring the stored data to a PC the USB output of the UT-3000 has to be connected to an USB interface of the PC. If you want to use the RS232 output, you have to change the factory setting (USB) first (see 2.4.1), then connect the RS232 output of the UT-3000 with a serial interface (COM1 or COM 2) of the PC, using a 1:1 connection cable.

Two sockets are available on the instrument back panel (see also chapter 3.5.2): a 9-pin D-Sub socket for connecting the UT-3000 to a COM-port of the PC and a USB socket for connecting the UT-3000 to a USB port of the PC.
If USB connection is used you have to install a USB driver (**CDM Driver** which comes with the Hg-Transfer software) on your PC first. The USB-driver is on the CD-ROM with the Hg-Transfer software.

3.6.2 Sending logged data to a PC by using Hyper terminal

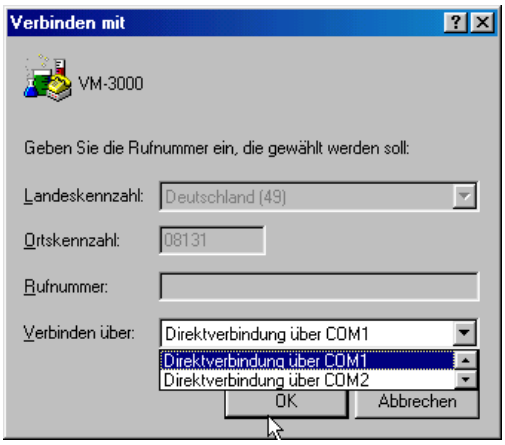
Select the Logger Mode menu as described under chapter 3.5.
Then following steps have to be performed on the PC (in WINDOWS):

- Select Start →All Programs → Accessories → Communications → Hyper Terminal.
- Start the program Hyper Terminal.

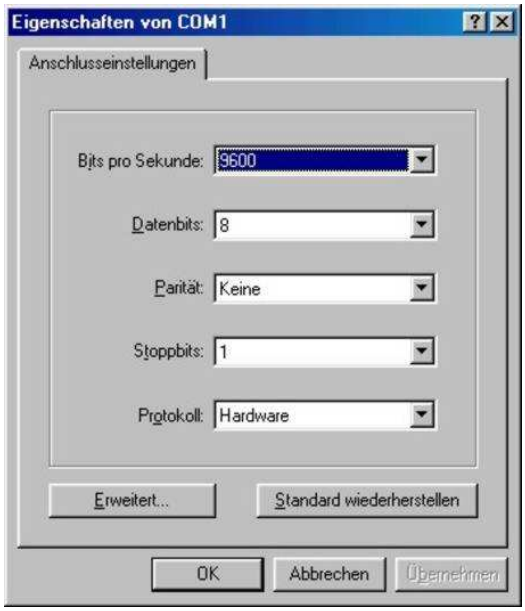


Enter a name for the connection (for example UT-3000), select a symbol and press OK.

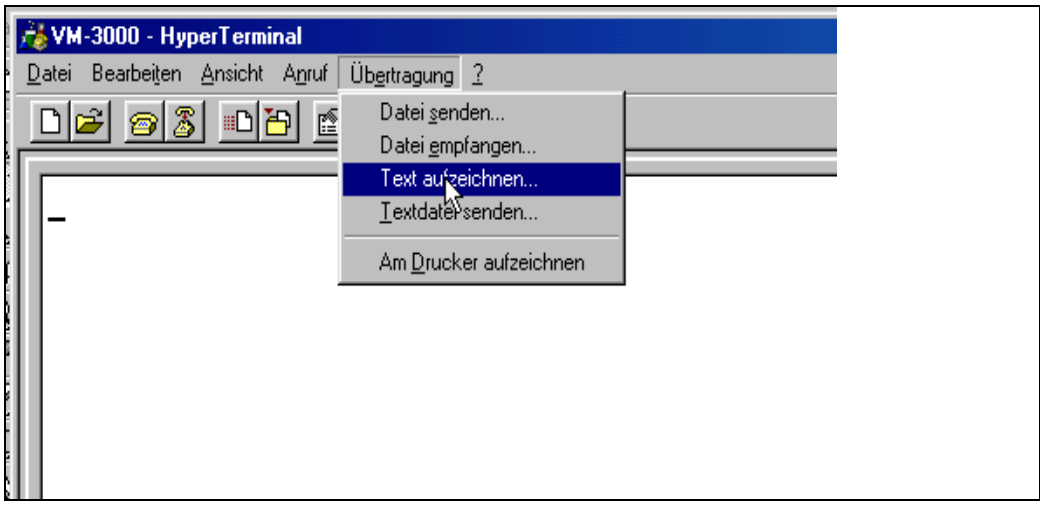
Select Direct Connection COM1 (or COM2 if used) and press OK.



Select Port Settings: 9600 bits per second / 8 data bits / parity: none / stop bit: 1 / Flow Control: hardware.Press the OK-bar.



Select the ***Transfer*** pull down menu. Select ***Capture Text***. Enter file name and press Start.



- Press ***F3-Send logdata to PC*** on the UT-3000.
- The logged data are now transferred from the UT-3000 to the PC. Starting date, starting time, sample volume and measurement data are transferred in this order. Data sets are separated by a carriage return.

3.6.3 Delete logged data

Select the Logger Mode as described above under 3.5.

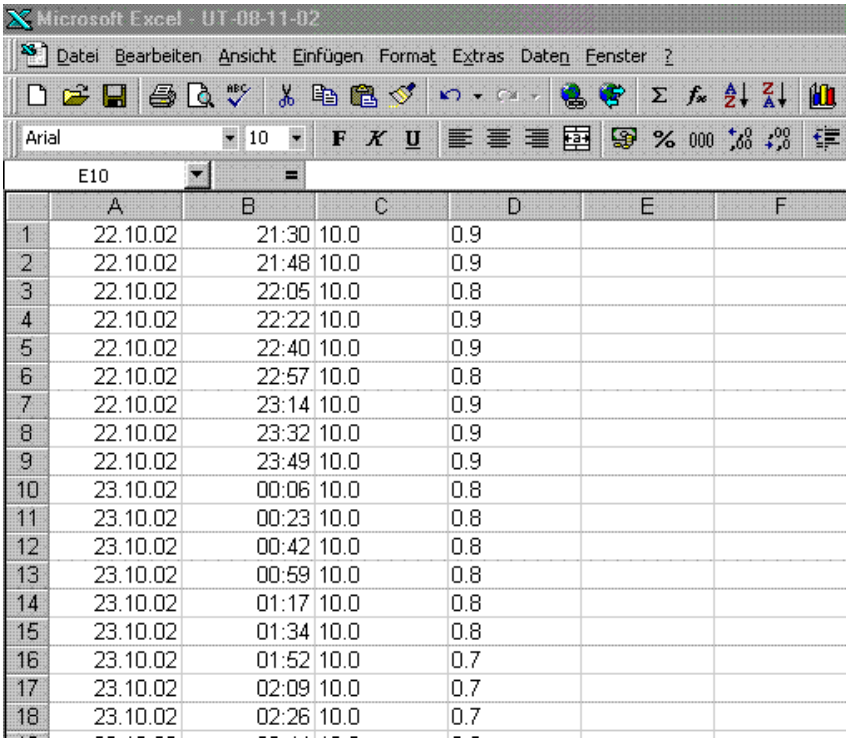
- Press F4- clear Logdata.

> ☞ **The Clear Logdata command will delete all measurement data stored in the RAM.**

3.6.4 Import of data into EXCEL

The data once stored as text file with **Hyper Terminal** can easily be imported into an EXCEL data sheet by selecting the data import function in EXCEL.

> ☞ Measurement data are sent using a point (“.”) for decimals. Depending on the setting of your EXCEL it may be necessary to convert the point into a comma (“,”). Use the search and replace function of EXCEL to do this quickly.



	A	B	C	D	E	F
1	22.10.02	21:30	10.0	0.9		
2	22.10.02	21:48	10.0	0.9		
3	22.10.02	22:05	10.0	0.8		
4	22.10.02	22:22	10.0	0.9		
5	22.10.02	22:40	10.0	0.9		
6	22.10.02	22:57	10.0	0.8		
7	22.10.02	23:14	10.0	0.9		
8	22.10.02	23:32	10.0	0.9		
9	22.10.02	23:49	10.0	0.9		
10	23.10.02	00:06	10.0	0.8		
11	23.10.02	00:23	10.0	0.8		
12	23.10.02	00:42	10.0	0.8		
13	23.10.02	00:59	10.0	0.8		
14	23.10.02	01:17	10.0	0.8		
15	23.10.02	01:34	10.0	0.8		
16	23.10.02	01:52	10.0	0.7		
17	23.10.02	02:09	10.0	0.7		
18	23.10.02	02:26	10.0	0.7		

FIGURE: LOGGED DATA IMPORTED INTO EXCEL: DATE, TIME, SAMPLE VOLUME, MERCURY CONCENTRATION [NG/M³]

3.6.5. Using the HG-Transfer Software for Data Transfer to a PC

Calibration and analysis data are sent via serial output of the UT-3000 to a connected computer using the **Hg-Transfer** software (comes with the instrument). The **Hg-Transfer** software has to be installed on the connected computer before data are transferred. Data can be displayed, stored (as .txt file or EXCEL® file) and printed.

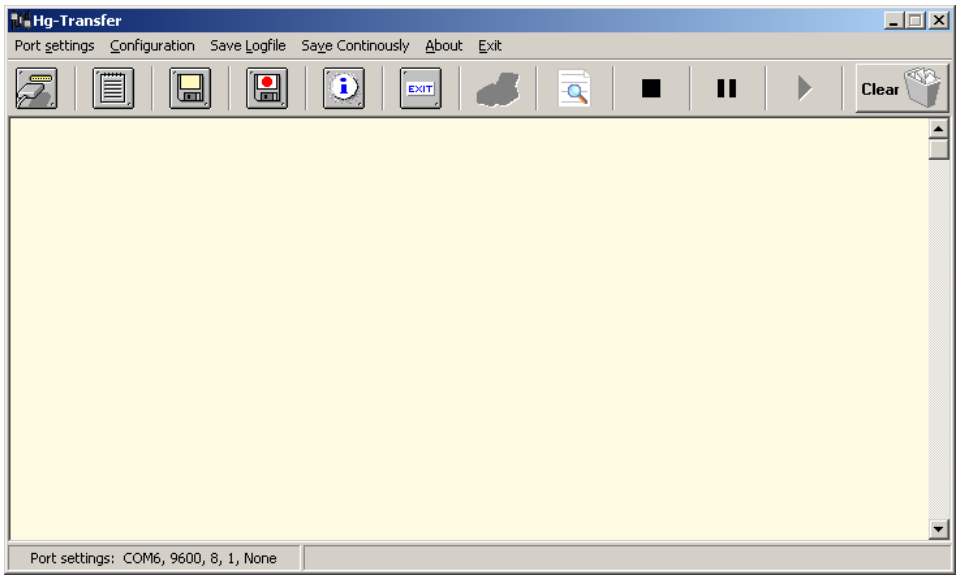
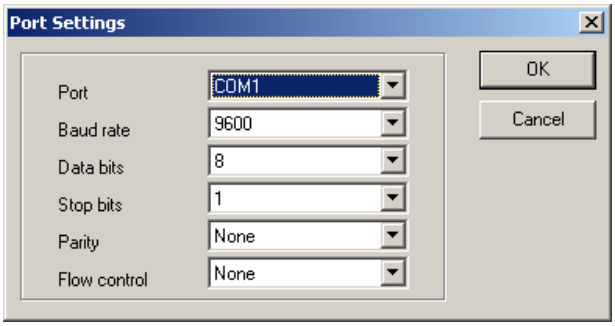
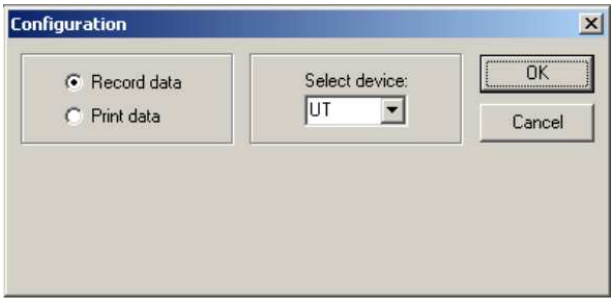


Figure: Hg-Transfer software main screen.

With choosing „**Port Settings**“ you can select the port of your computer used for connection with the VM-3000 and the communication parameters.



By choosing „**Configuration“** you can choose the type of analyzer:
UT = UT-3000.

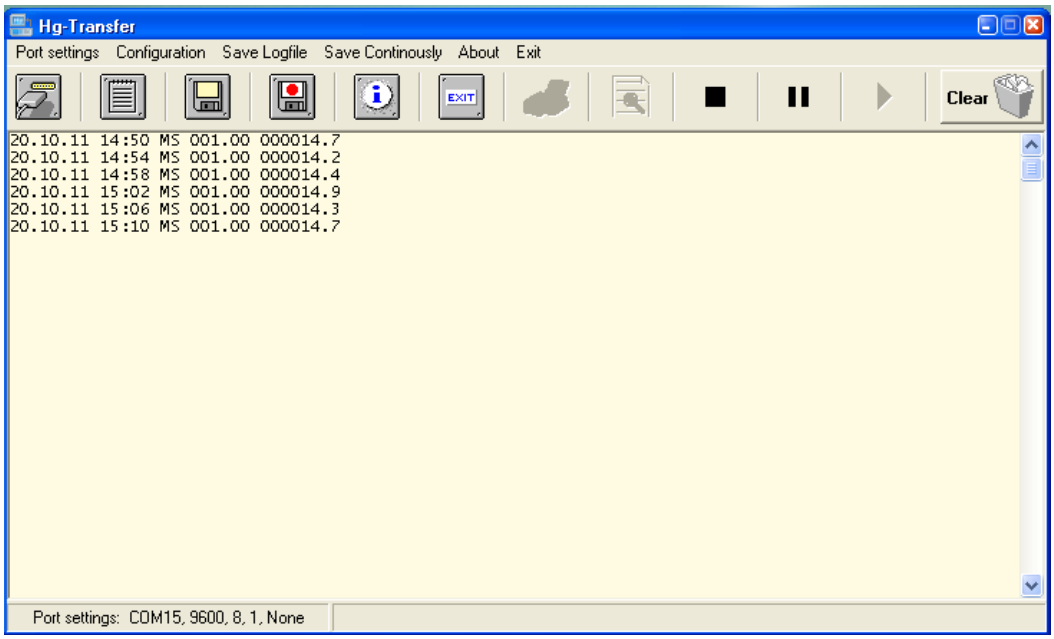


Transferring of the data from the UT-3000 to the PC is started by clicking onto the start icon.

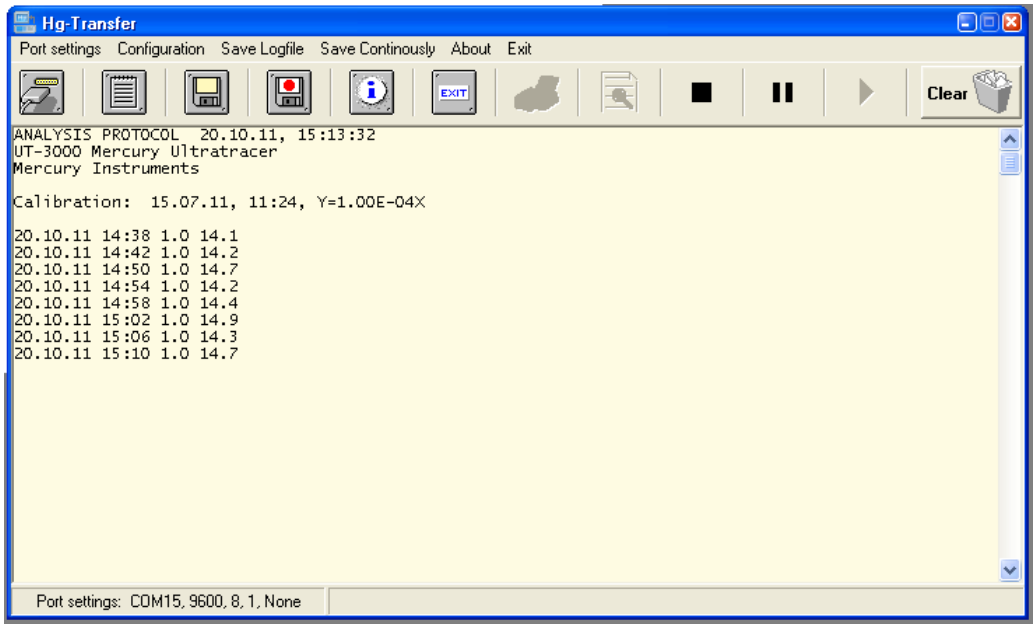
During measuring there is a continuous transfer of readings.

The following data are shown:

Date Time Status Sample Volume Measured Value



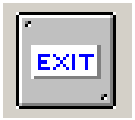
When there are already logged data stored in the UT-3000, the whole log-file can be sent to the PC using the Hg-Transfer-Software.



The values displayed in the Hg-Transfer window can be stored with the **Save Logfile** command (EXCEL® format).

With the **Save Continuously** command results of a running measurement are continuously stored (EXCEL® format).

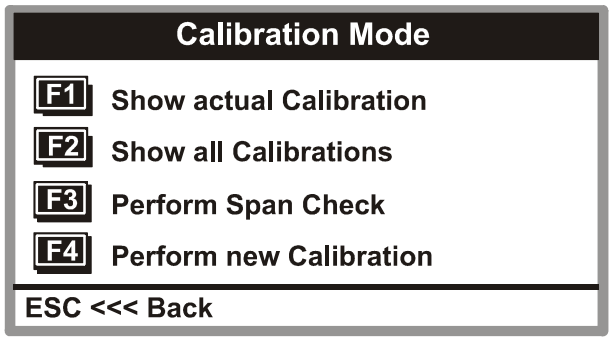
With pressing **About** (i) you can check which version of hg-Transfer-Software you are using.



With choosing Exit you are leaving the Hg-Transfer software.

4. Calibration

A calibration is recommended to be performed regularly according to applied quality standards. Go to the main menu and press **F4: Calibration**.



In the Calibration Mode menu you can select:

F1- to show the last performed calibration

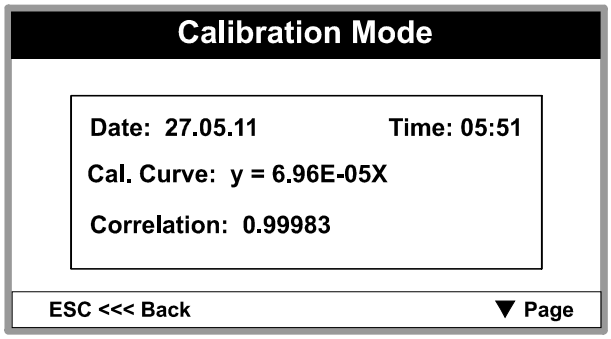
F2- to show the history of all calibration data (can be deleted with **F4)**

F3- to perform a span check

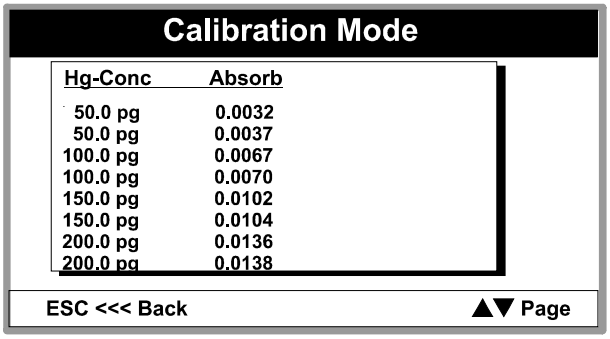
F4- to perform a new calibration.

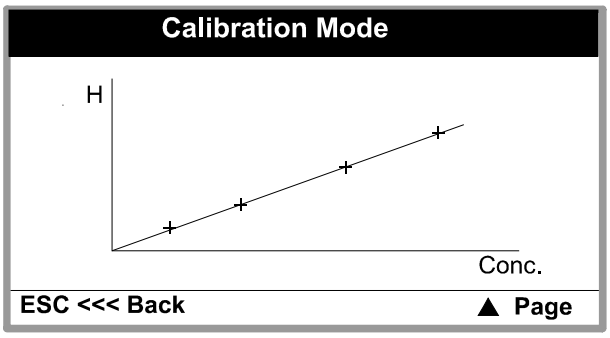
4.1 Show actual calibration

Press F1 in the Calibration Mode menu. The actual calibration parameters are displayed on the screen.



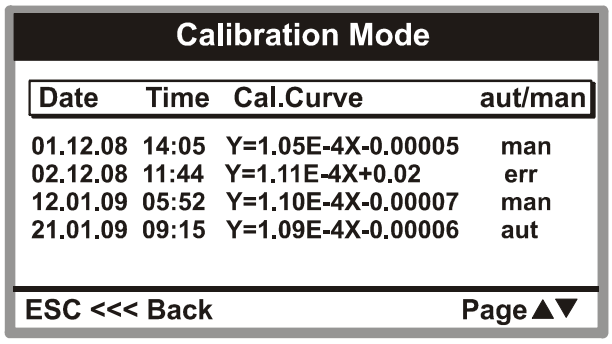
By pressing the arrow-key one can have a look on the calibration data and on the calibration curve.





4.2 Show all calibrations

Press **F2** in the Calibration Mode menu. A list indicating all previously stored calibrations is displayed.



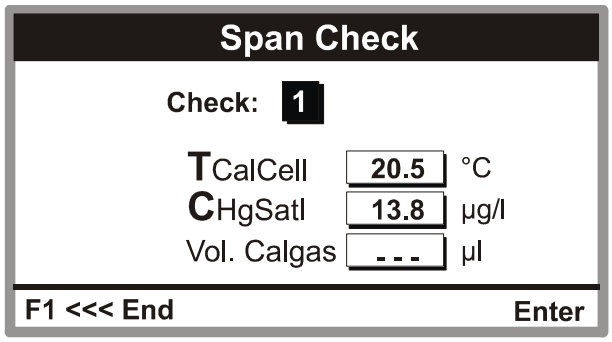
The three-letter-code in the right column means:

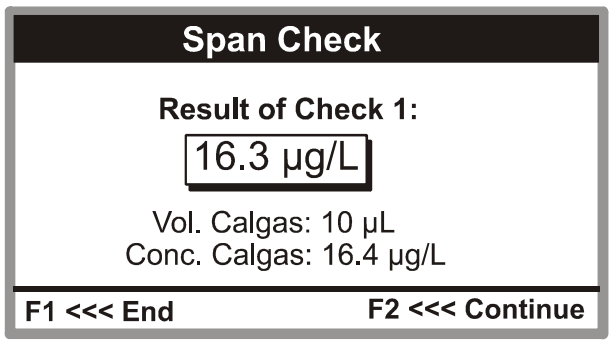
man	manual calibration
aut	automatic calibration
err	calibration data of an automatic calibration were out of range; in this case the data of the previous calibration are used. Allowed range of calibration equation: Y= aX+b; where 0.00002<a<0.00015 and –0.001<b<0.001

NOTE: the calibration data table can completely be cleared by pressing F4 !

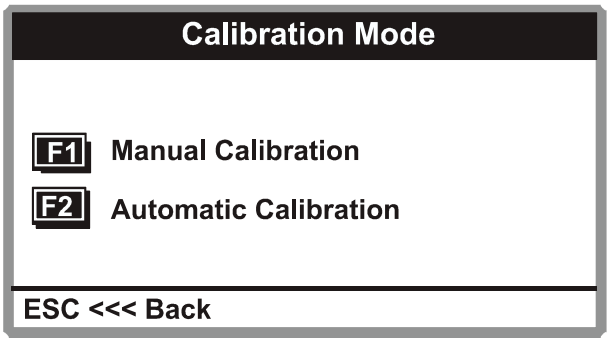
4.3 Perform Span Check

If **F3- Perform Span Check** is selected in the Calibration Mode menu a manual span check can be performed. A calibration unit (see 4.4.2) has to be connected by cable (Pt100), this tells the analyzer the mercury concentration of the calibration gas.
After pressing the F3-button the analyzer will be prepared for the span check by the standard cleaning routine of GoldTrap : **Zeroing / Trap cleaning / Trap cooling / Zeroing / Trap cleaning / Trap cooling / Zeroing / System Evaluation / Trap cooling.**
Then a volume of calibration gas has to be injected into the calibration port on the front side of the analyzer. The volume (1-999 µl) has to be typed in and confirmed by pressing ENT.



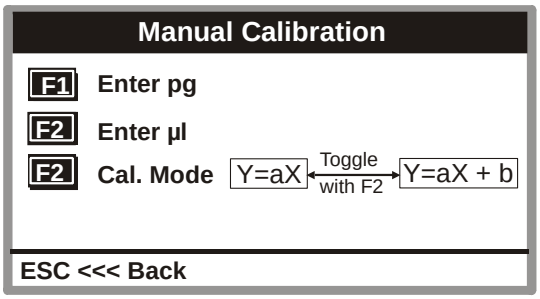


4.4 Perform New Calibration: Manual Calibration



F1 is pressed in the Calibration Mode menu in order to perform a manual calibration.
Now you can select if a known **mass** of mercury or a known **volume** of mercury calibration gas is injected into the calibration gas port: ***F1- Enter pg*** or ***F2- Enter µl***.

☞ **Note: the F2- Enter µl command can only be used with the Static Calibration Set (available as an accessory to the UT-3000) connected to the UT-3000.**



By pressing **F2** the type of calibration function can be selected: **with** zero offset (Y= aX+b) or **without** zero offset (Y= aX).

☞ For manual calibration the calibration function Y=aX is recommended.

4.4.1 Manual Calibration: Enter pg

☞ **Go to 4.4.1.2 if the Calibration Set A (supplied as an accessory for the UT-3000) is used as a calibration gas source.**

This mode is used if a known mercury mass is injected into the Calibration Port of the UT-3000 using a calibrated syringe. It is possible to use any mercury calibration gas source, for example as described in method VDI 2267/Part 8 [*Measurement of the mass concentration of mercury. Sampling by sorption as amalgam and determination by atomic absorption spectrometry (AAS) with cold vapor technique*].

The calibration is carried out by following steps:

a) Make sure a new septum has been inserted in the instrument calibration port.

b) Press **F1- Enter pg.**

c) Type the mass of mercury [in pico-gram Hg] which is contained in the injected volume and press **ENT.**

d) Fill the syringe to be used with calibration gas from the calibration device.

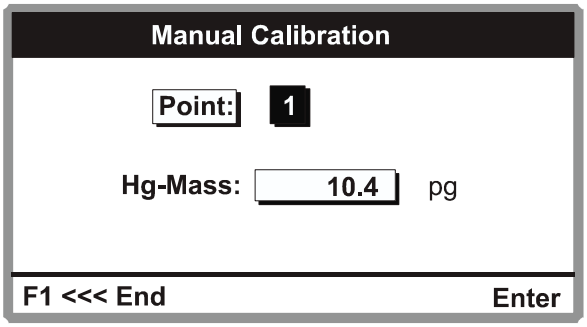
e) Push the capillary of the syringe through the septum of the calibration port on the front panel of the UT-3000 and inject the calibration gas.

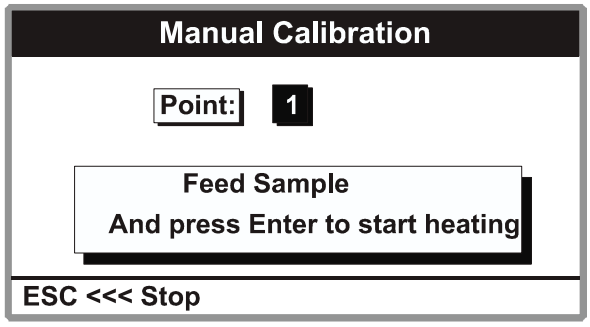
f) Press **ENT.** After a pause of 10 seconds the GoldTrap is automatically heated and the measuring signal is recorded.

g) Repeat step **a-d** for additional calibration points.

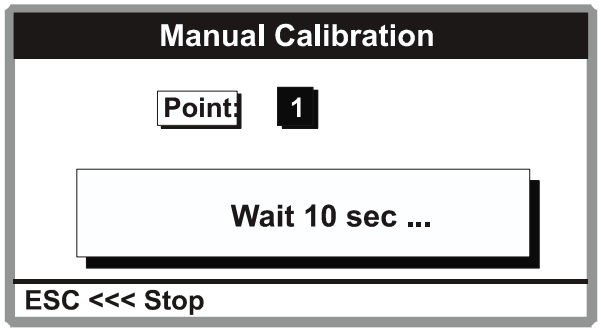
h) Press **F1** if no further calibration points should be measured.

Enter the mass of mercury to be injected into the calibration port. Recommended range for calibration: 10 … 5000 pg for full range measurements or 10 ... 500 pg for low range measurements.



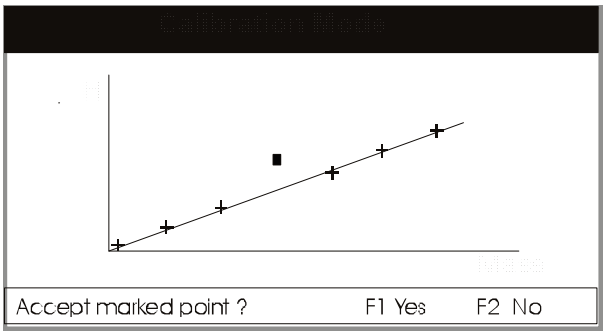


Inject calibration gas and press **ENT.**

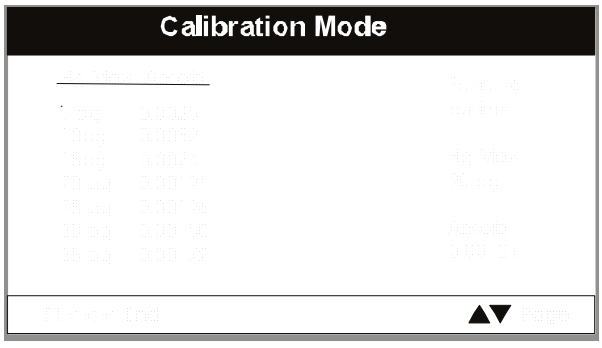


Waiting time 10 sec.

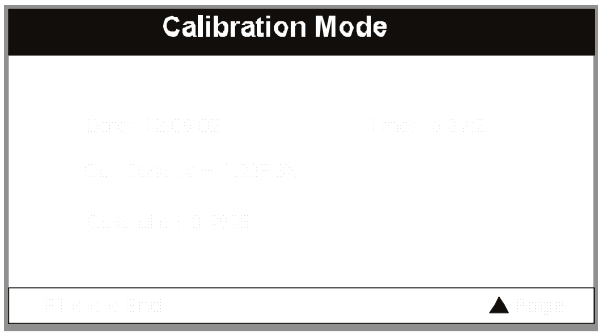
End of Calibration
If the last calibration standard has been injected, press **F1- End**. Now the calibration function is calculated automatically. An outlier is marked as a square. It can be accepted to be included in the calibration function (**F1- Yes**) or it can be excluded from the calibration function (**F2- No**).



If the outlier is **not** accepted (**F2- No**), the user is asked to repeat the calibration point.



On a second page calibration data are displayed.



On a third page the parameters of the calibration function are displayed.

The main menu is displayed again after the calibration mode is left.

Practical recommendations for performing a calibration:
Mercury masses should be within the same range like the measuring range. Static calibration sources (= mercury filled bottles with headspace) deliver calibration gas with comparatively high mercury concentrations (ca. 12 - 14 pg/µl at room temperature). For a low measuring range of 0.1 to 10 ng/m³ the mercury masses injected should be ideally from 1 pg to 100 pg. However, 1 pg will be difficult to apply as this would require at room temperature a very small volume (0.1 µl) which is not practical. In practice, volumes from 1 µl to 100 µl will be used.

☞ **Use the syringe delivered with the Static Calibration Set or alternatively a syringe with a capillary length of 50-52 mm ! Do not use a syringe with a different capillary length !**

How to calculate the mercury mass ?
Read the temperature of the mercury calibration bottle as exactly as possible.
Determine the mercury concentration from either the table which usually comes together with the calibration device or from below calculation formula.
Calculation of mercury saturation concentration in headspace after equilibration:

$$\text{conc. Hg} = \frac{A}{T} \cdot 10^{\left(B - \frac{C}{T}\right)} \quad [\mu g/l]$$

where: A= 3216522.61
B= 8.134459741
C= 3240.871534
T= absolute temperature (= Temperature in °C + 273.2)

From the mercury concentration calculate the mass of mercury which is in the volume which shall be injected. For example, if the mercury concentration of the calibration gas is 16.700 µl/l, one µl contains 16.7 pg Hg and 10 µl will contain 167 pg Hg.

4.4.2 Manual Calibration: Enter µl

A Mercury Instruments **Static Calibration Set** is connected to the UT-3000. The user has only to enter the volume of the injected calibration gas and the instrument automatically calculates the mercury mass from volume injected and calibration cell temperature. For calibrations in the lowest measuring range it is recommended to use volumes from 1 µl to 10 µl.

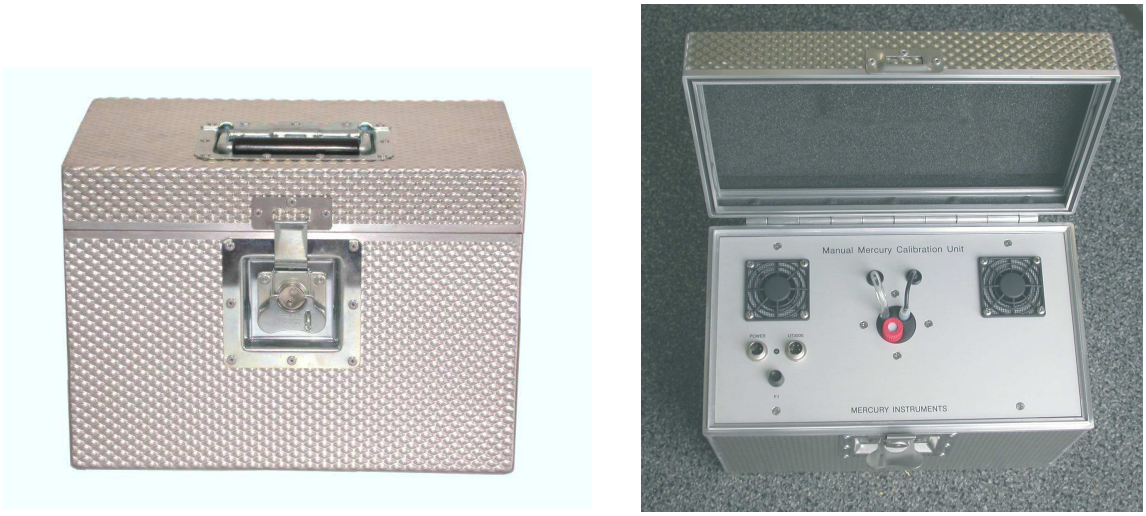


FIGURE: CALIBRATION SET FOR MANUAL CALBRATION (LEFT: CLOSED; RIGHT: OPENED)

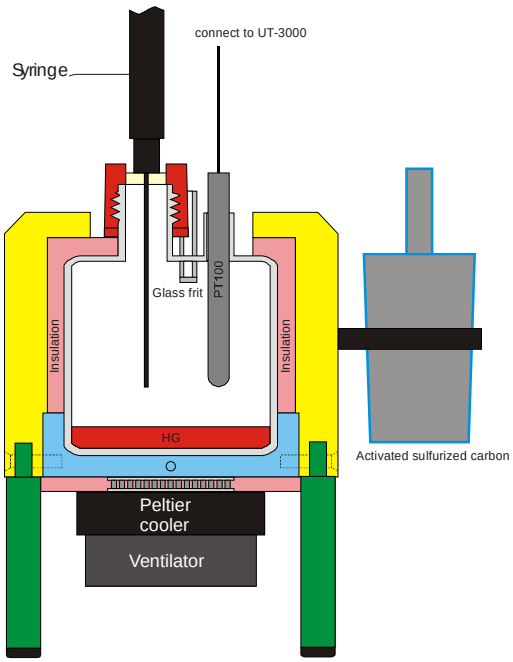


FIGURE: SCHEMATIC DRAWING OF THE MERCURY CELL OF THE STATIC CALIBRATION SOURCE.

The Mercury Instruments Calibration System consists of a specially designed mercury vessel surrounded by an aluminium jacket that is cooled by a thermoelectric cooler. The temperature of the mercury vessel is exactly measured with a high precision temperature sensor. The mercury chamber contains elemental mercury of high purity. The electronic temperature sensor has to be connected to the UT-3000 ULTRATRACER using the cable delivered with the system. The temperature of the calibration gas and the concentration of mercury are displayed on the UT-3000 screen if a calibration is performed.

Using the Static Calibration Unit:

☞ **CAUTION: never tilt the Static Calibration Unit nor turn it over during use! Prevent from shocks !**
For transportation remove the septum cap from the mercury vessel and close it with a screw cap. Do not apply force to the mercury containing glass bottle !
Used septum may have small mercury droplets on its surface: be careful when removing it. Use a small piece of wire (paper clip) to remove the septum from the red plastic cap. Place septum and wire into a plastic bag for disposal.

a) Place the calibration unit on a clean, stable and flat surface.
Make sure that the room is well ventilated or use a fume hood whenever you open the mercury cell !
Take the red septum cap and make sure that **a new septum** has been inserted.
Open the cover of the calibration unit by twisting the latch. Remove the red cap which closes the mercury cell for transportation and store it in a safe place. Note that there may be small droplets of mercury clinging onto the surface of the septum, therefore **handle the cap and the septum with care !** Do not touch the septum with fingers. Screw the red septum cap (with a new septum !) onto the glass thread of the calibration cell.

b) Connect the power supply (round plug) to the calibration unit. The green LED will light and the internal Peltier cooler will start to operate.

c) Allow the system to stabilize for at least one hour.

d) Take the syringe which is included in the system and hold it vertically. Push the capillary of the syringe carefully through the septum of the calibration unit as far as possible, always holding it vertically.
Do not apply too much force to the septum and the screw cap, as these are mounted onto a glass bottle which contains the mercury.

Important: hold the syringe vertically as long as the tip of the capillary is inside the calibration cell ! Otherwise there is the risk of contamination of the syringe with liquid mercury which finally may result in a contamination of the calibration port of the UT-3000 analyzer.

e) Purge the syringe with calibration gas by pulling and pushing the plunger slowly a few times. Then pull the plunger a little bit further than it is necessary to get the desired volume and pull the syringe vertically out from the septum.

f) Move the plunger exactly to the desired volume and push the tip of the syringe capillary into the septum of the of the calibration port on the front panel of the UT-3000. Push it all the way as far as possible to make sure the tip is at the correct position. Try to center the capillary so that it can penetrate the calibration port without getting stuck. Inject the calibration gas by pushing the plunger of the syringe slowly. Then pull the capillary out of the calibration port and put the syringe down.

☞ **CAUTION: Contamination of parts of the syringe or the calibration port of the UT-3000 with liquid mercury has strictly to be avoided ! Even smallest droplets of mercury which cling to the syringe capillary or the septum of either the calibration device or the calibration port will cause a severe contamination. Indication for a contamination are: too high absorbance values of calibration points, erratically scattered calibration points, unexpected high measurement peaks. In this case all the equipment which may have been contaminated has to be exchanged, including septa, syringe capillary or even the whole syringe if contaminated inside.**

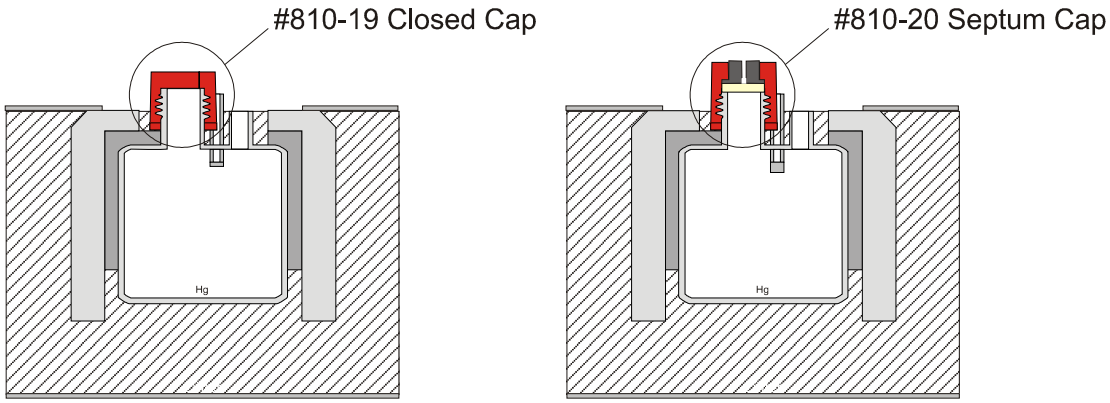
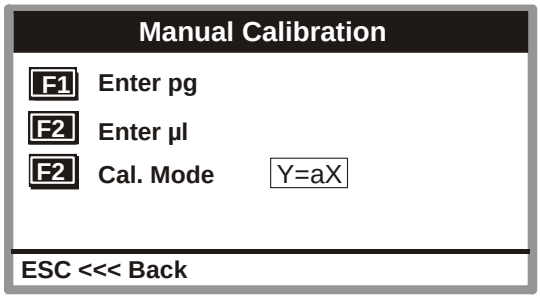


Figure: use closed cap for transportation (left) and septum cap for calibration (right)

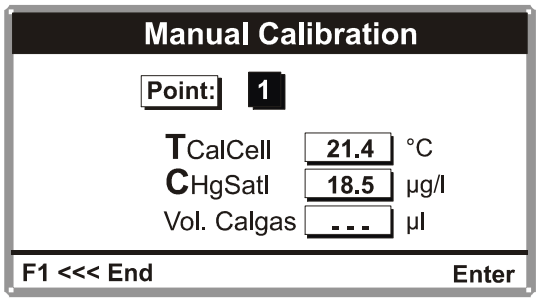
Performing a manual calibration using the Static Calibration:

1. Make sure a **new septum** has been inserted in the calibration port of the instrument.

2. Check if for Cal. Mode X= aX is selected (recommended), now press **F2- Enter µl in the *Manual Calibration* menu.**



3. The temperature and the saturation concentration of the calibration cell will be displayed. Type the volume of mercury which is to be injected and press **ENT.**
   For the first calibration point it is recommended to enter "0" for the volume, in this case no calibration gas has to be injected.



4. Inject the chosen volume of calibration gas following the steps **a-f** of the above description of how using the static calibration source.
5. Press **ENT.** After a pause of 10 seconds the GoldTrap is automatically heated and the measuring signal is recorded.
6. Repeat step 1-3 for additional calibration points.
7. Press **F1** if no further calibration points should be measured.

Now the calibration data will be displayed as described in the following.

FIGURE: PULLING A VOLUME OF CALIBRATION GAS FROM THE CALIBRATION CELL WITH A 10 µL SYRINGE

.

NOTE: hold the syringe in a vertical position to avoid contamination !

FIGURE: INJECTION OF CALIBRATION GAS INTO THE CALIBRATION PORT OF THE UT-3000

4.4.3 Examples for calibration functions

The calibration is linear over a wide range up to ca. 5000 pg Hg absolutely (equivalent to 5 µg/m³ for 1 litre sample volume or 0.5 µg/m³ for a 10 l sample volume). Above this range the calibration is automatically calculated using a polynomial function which is useful up to ca. 15000 pg Hg (equivalent to 15 µg/m³ for a 1 litre sample volume).

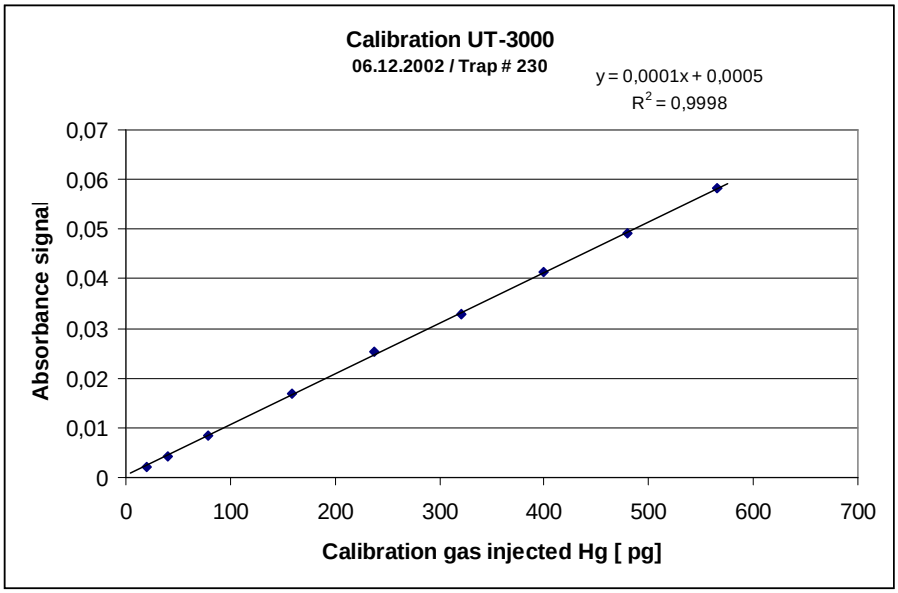


FIGURE: CALIBRATION GRAPH FOR 0 … 600 PG HG RANGE

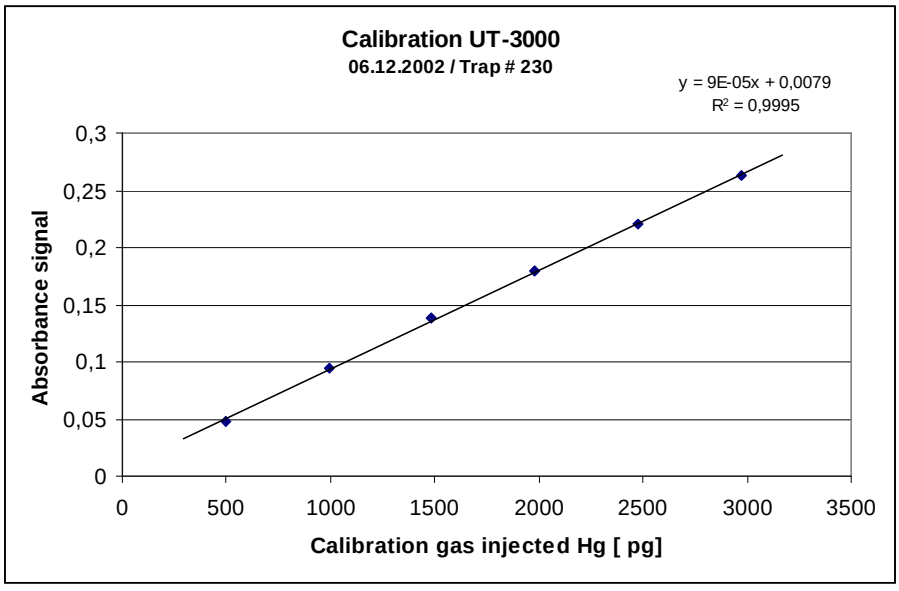


FIGURE: CALIBRATION GRAPH FOR 500 …3000 PG HG RANGE

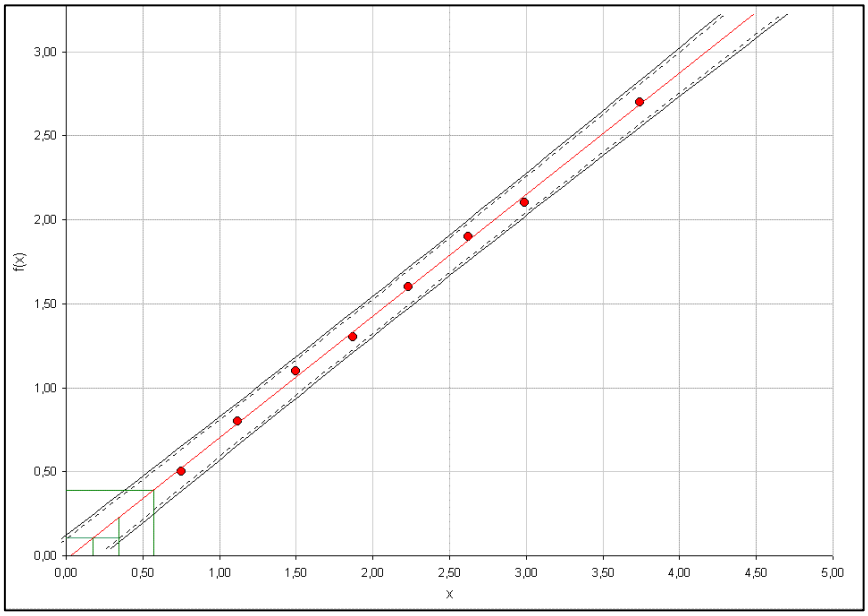


FIGURE: CALIBRATION GRAPH IN LOW RANGE (0-3,5 NG/M³) WITH CONFIDENCE RANGE

4.5 Perform New Calibration: Automatic Calibration (Option)

The UT-3000 Ultratracer can be equipped with the Automatic Calibration Unit which is available as an accessory. This unit has a Peltier element cooled mercury saturation chamber, from which saturated air is drawn by means of a digital syringe. This air is injected automatically in a stream of zero air entering the UT-3000.
It is recommended to place or mount this unit under the UT-3000.

> ☞ **It is important to install all connections between the Automatic Calibration Unit and the UT-3000 before the system is set into operation !**

FIGURE: AUTOMATIC CALIBRATION UNIT FOR UT-3000

4.5.1 Connecting the Automatic Calibration Unit with the UT-3000

a) The calibration gas outlet tubing of the Calibration Gas Unit has to be connected with the calibration gas inlet tubing of the UT-3000 (see figure below).

b) The cable for the temperature sensor (two round 4-pin plugs) has to be connected with the according sockets on the rear side of the UT-3000 and the Automatic Calibration Unit.

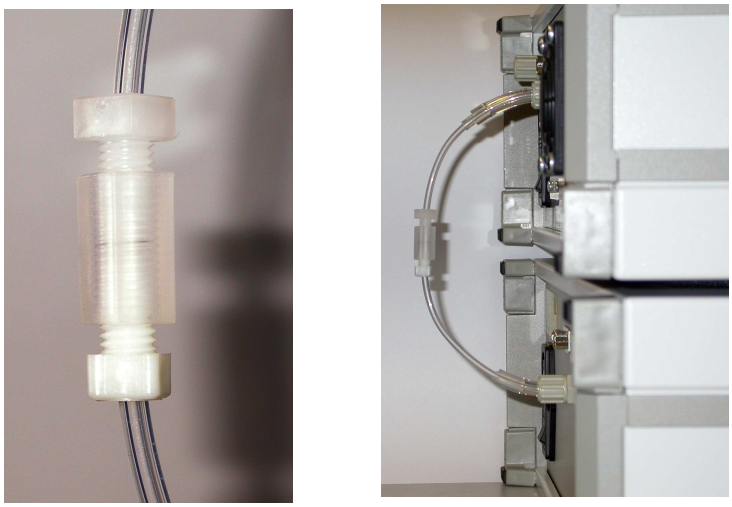
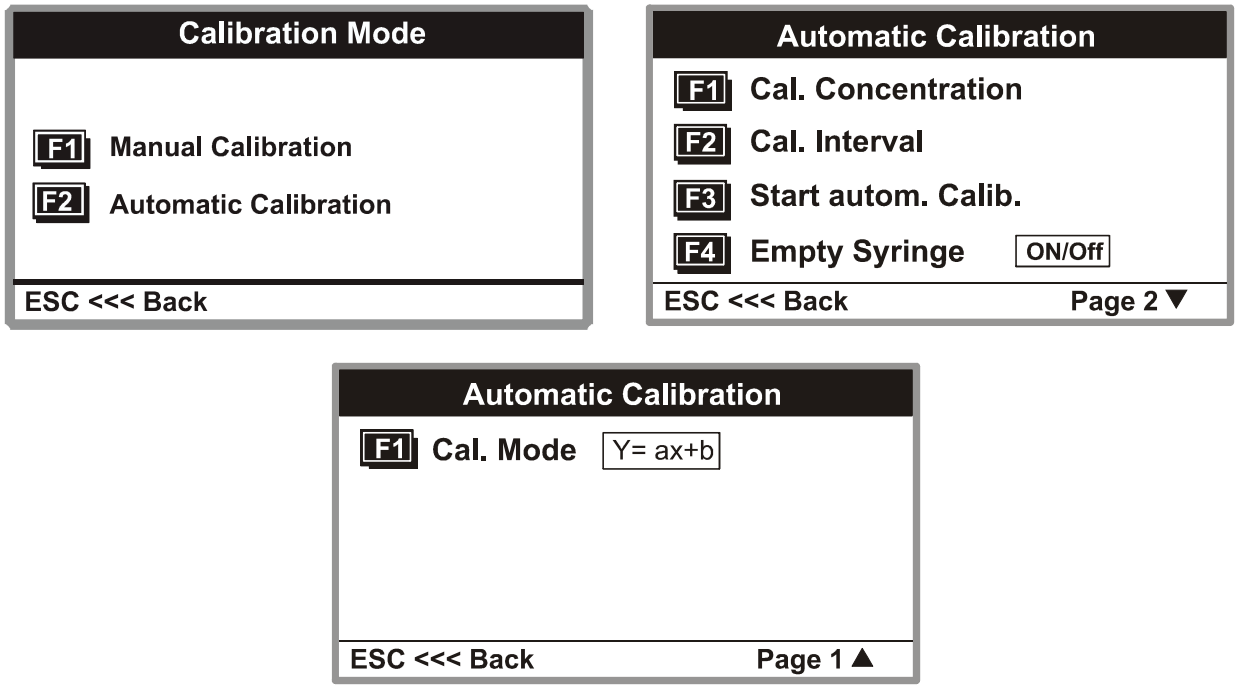


FIGURE: CONNECTION OF TUBING ON BACK SIDE OF UT-3000 AND OF AUTOMATIC CALIBRATION UNIT

4.5.2 Activating the Automatic Calibration Function

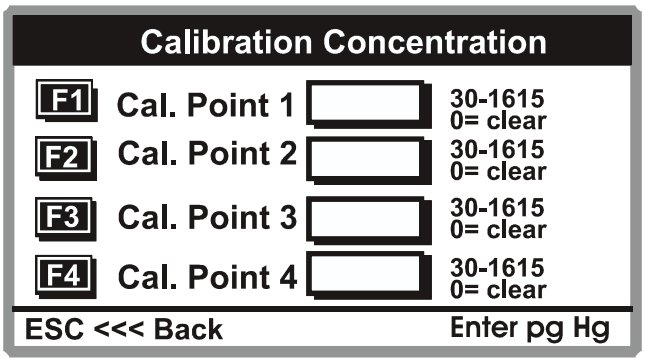
Switch on the Automatic Calibration Unit first, then switch on the UT-3000.
After Lamp has stabilized and the main menu is displayed press **ESC** and enter the code **777 + ENT.** Now activate the automatic calibration mode. Press **ESC** again to return to the main menu.



4.5.3 Cal. Concentration

F2- Automatic Calibration is selected in the Calibration Mode menu.

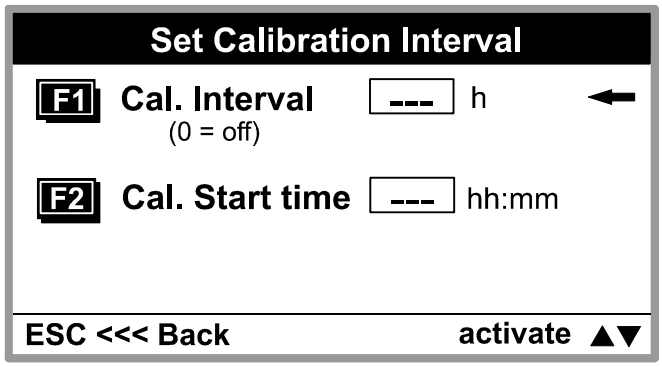
Now **press F1-Cal. Concentration** to enter concentrations used for calibration. Up to twelve calibration points can be entered.



If finished press **ESC.**

4.5.4 Cal. Interval

F2- Cal. Interval: calibration start time or interval between automatic calibrations:



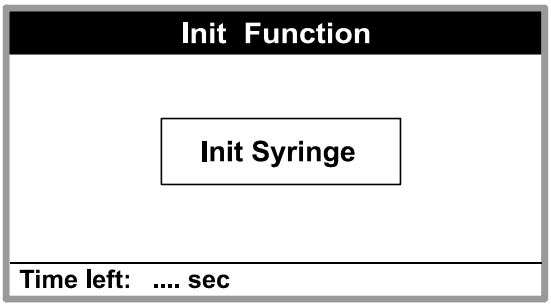
You can enter either a time interval (1-24 hours) which determines the time between two automatic calibrations or a fixed start time at which the automatic calibration will start daily.

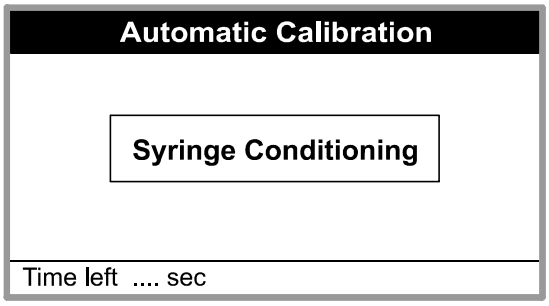
The arrow indicates the active mode, it can be changed with the 68-keys.

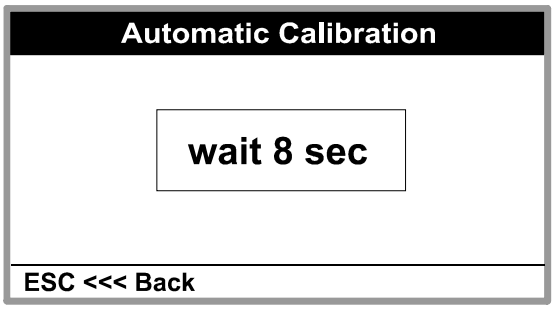
4.5.5 Manual Start of the Automatic Calibration

F3- Start automatic Calibration is selected in the Calibration Mode menu. Now an automatic calibration is immediately started using the concentrations entered under F1-Cal. Concentration.

The following screens can be noticed consecutively:

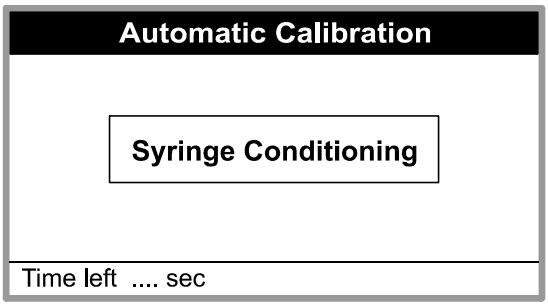


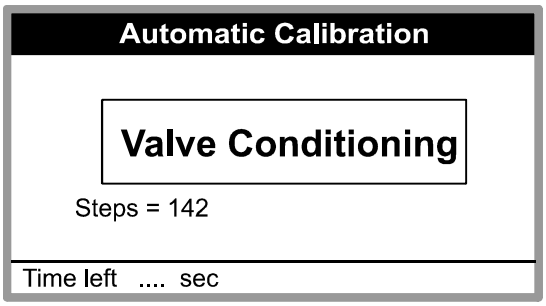




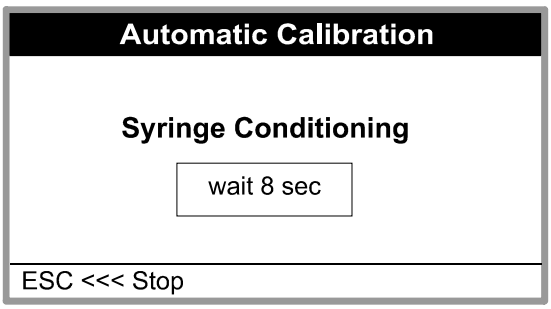
After that the standard cleaning routine of the GoldTrap is done:

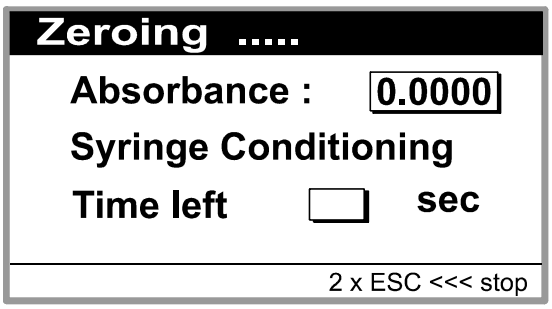
Trap Cleaning / Trap Cooling / Zeroing / Trap Cleaning / Trap Cooling / Zeroing / Trap Cleaning / Trap Cooling





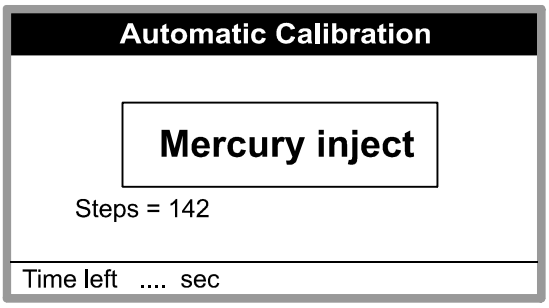
Now the routine for each calibration point is starting and repeated as often as your amount of different concentrations.

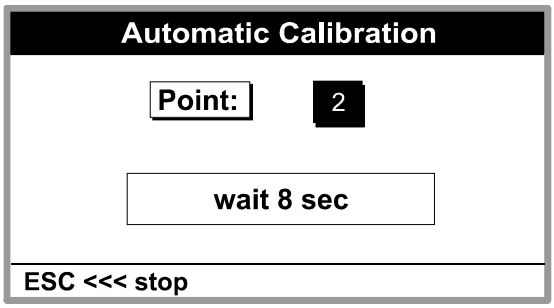




After that there is again a short cleaning sequence of the GoldTrap:

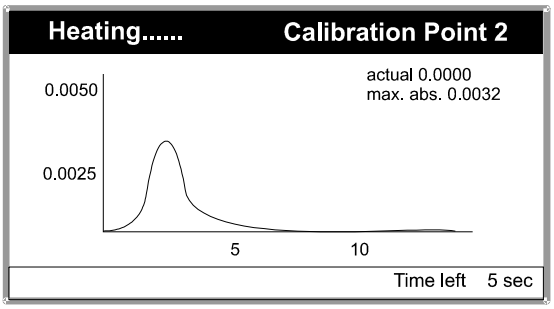
Heating / Trap Cooling / Zeroing / Trap Cleaning / Trap Cooling / Syringe Conditioning





The amount of indicated steps are calculated from the concentration levels you have fixed in the calibration concentration menue (4.5.3).

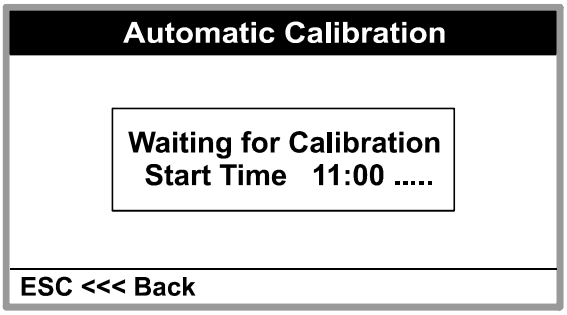
After a another short zeroing you get the heating peak of the injected mercury concentration.



4.5.6 Automatic Start of the Calibration

The sequence of the calibration routine is the same than in the chapter before of the manual starting. There is just one difference:

When you have fixed a calibration interval or a calibration time there is an automatic check before the start of calibration whether the time span to the calibration is shorter than the next measuring cycle. If this is the case there will be a stop of the measuring and it's shown the following screen:



4.5.7 Empty Syringe

F4- Empty Syringe is selected in the Calibration Mode menu. By pressing F4 this function can be switched on or off. If **Empty Syringe** is **On**, then after each mercury injection the syringe is filled with air and re-injected into the gold trap.

4.5.8 Cal. Mode

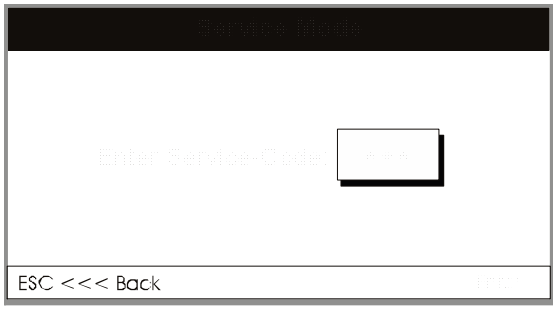
Page 2 of the Automatic Calibration Menu, press **F1- Cal. Mode.** In this menu the kind of calibration function calculated from the calibration results can be set: either a linear least square regression (Y= aX+B) or a regression without intercept (Y= aX).

4.5.9 Activation of Automatic Span Calibration

This function has to be activated if an automatic one-point calibration should be performed. It is also necessary to activate this function if an externally triggered span check should be carried out.
Press **ESC- Service** in the Main menu. Enter the code **999** + **ENT**. Activate the Automatic Calibration Mode (**F1**) or the Automatic Span Calibration (**F2**). The automatic calibration or the automatic span calibration will be carried out at the pre-set time intervals or at the pre-set times if measurement has been started.

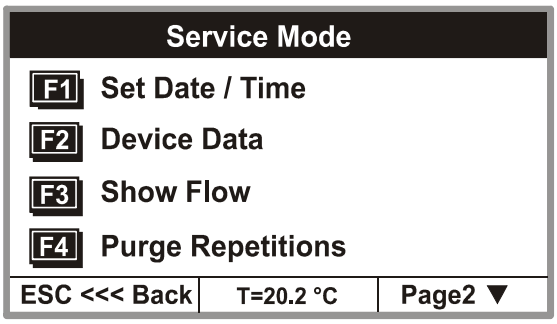
5. Service-Menu

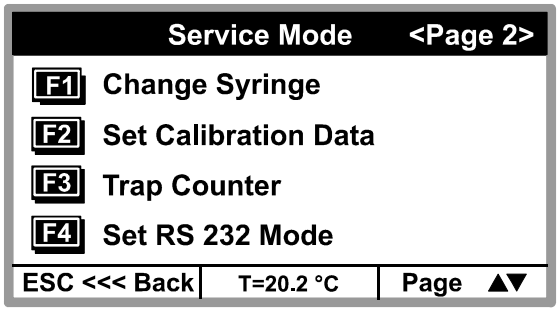
If **ESC- Service** is pressed in the main menu the service code input mask will appear on the display.

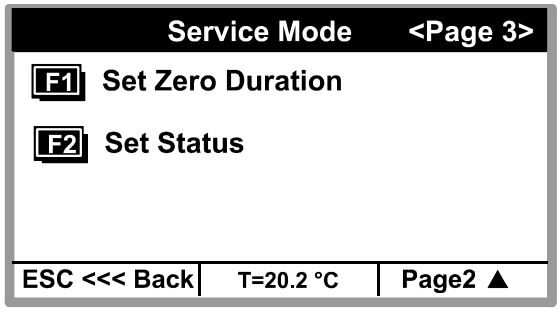


Enter the code **3 2 1 + ENT**

Now the Service menu is displayed. In the centre of the bottom line the temperature of a connected calibration device is indicated.







5.1 Set Date and Time

Press **F1- Set date / time** in the service menu.
The date can be edited by pressing **F1** and the time by pressing **F2**.

5.2 Device Data

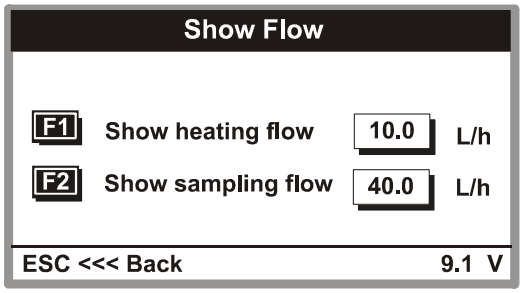
In this screen information for the service engineer is displayed (operational hours, lamp voltage, heating coil cycles, software version)

5.3 Show Flow

In this screen the flow for sampling and the flow during thermal desorption of the mercury from the GoldTrap (heating flow) can be read.

a) Heating flow: press **F1.** Stop flow reading by pressing **ESC.**

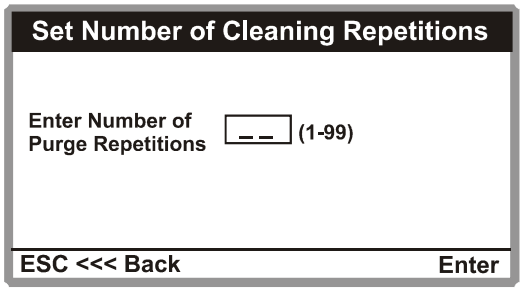
b) Sampling flow: press **F2**. Stop flow reading by pressing **ESC.**



The allowed range for heating flow is 8.5 – 11.5 l/h, for sampling flow 38 – 42 l/h. An error message will appear if the flow is out of these ranges. The value displayed on the right bottom is the pump voltage. The allowed range for this voltage is 6 – 11 V. During measurement mode an error message will appear if the voltage is out of this range.

5.4 Purge Repetitions (for Automatic Calibration Option only)

The parameter set for purge repetitions is only available when the automatic calibration mode has been activated. It determines how often the automatic syringe is purged with calibration gas for conditioning.

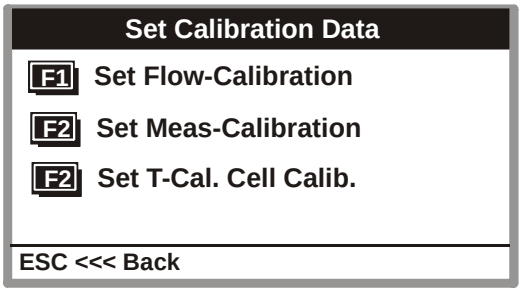


5.5 Change Syringe (for Automatic Calibration Option only)

This function is only available when the Automatic Calibration function has been activated (Service code 777). It is necessary for change of the syringe inside the Automatic Calibration Unit. The command **Change Syringe** moves the piston of the syringe to a 50 % position which is necessary to remove the syringe. The **Reset** command pushes the piston back again into the syringe.

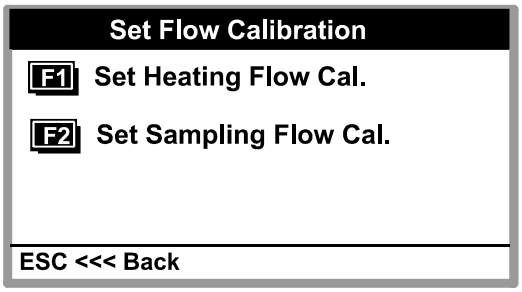
5.6 Set Calibration Data

In this window calibration parameters for the built in mass flow sensor and the parameters of the analytical calibration can be set. This is useful if these values are lost due to service work.



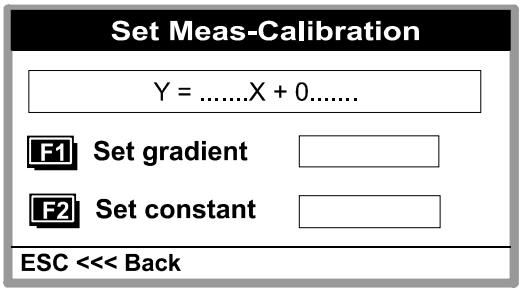
5.6.1 Set Flow Calibration

By pressing **F1 – Set Flow-Calibration** you can enter manually the calibration data of the internal mass flow controller, in case they are deleted (for example if the microprocessor-battery is empty). You will find those data on the test-certificate of your UT-3000, which was in the delivery amount.



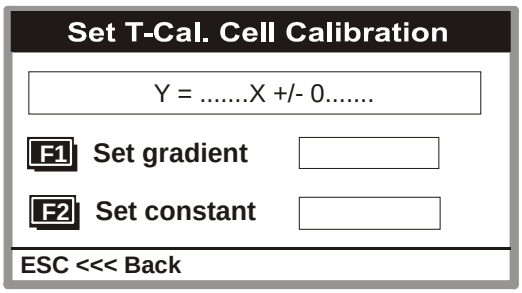
5.6.2 Set Measuring Calibration

By pressing **F2 – Set Meas-Calibration** you can enter manually the values of the measuring calibration, in case they are deleted.



5.6.3 Set T-Cal. Cell Calibration

By pressing **F3 – Set T-Cal.Cell Calibration** you can enter manually the values for the calibration of the temperature sensor of the calibration device (either manual or automatic calibrator).



5.7 Trap Counter

This window displays the total number of heating cycles of the GoldTrap ever carried out.

5.8 Set RS232 Mode

As a standard the RS232 output delivers measurement data sequentially as ASCII characters. Optionally data can be output following a protocol for data acquisition systems from ISEO (France).

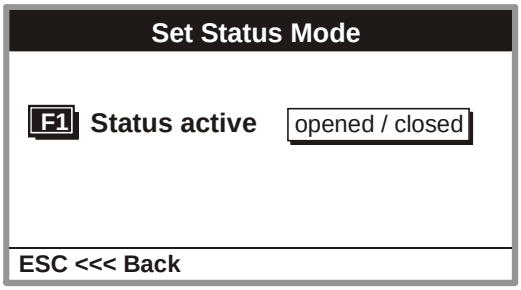
5.9 Set Zero Duration

The instrument performs an automatic zero adjustment before each trap heating step (see also chapter 3.5). In this menu the duration of the zeroing can be set to a value between 11 seconds and 250 seconds. Standard setting is 11 seconds. This parameter has to be increased if during operation of the system with real sample it is found that the reading towards the end of zeroing is

not close to 0.00000 and still decreasing. This may be due to extremely high mercury concentration or high benzene concentrations in the sample.

5.10 Set Status

In this window the function of the status contacts can be programmed, so that they will be opened or closed when activated.



5.11 Special Service Codes

Following codes are available:

Code:	Function:	Recommended Setting
321	Standard Service Menu, see beginning of this chapter	n.a.
191	Standard / Tedlar Bag Mode	Standard (Tedlar Bag Mode is an option for special applications)
222	Offset T Cal.Cell / Zero Offset / Heating Flow / Heating Flow Regulate	0.00 °C / 0.0000 / 10 l/h /ON
333	Evaluation Graph on/off	ON
753	*Flow Calibration (10 l/min – 3 points; 40 l/min – 3 points)*	*Only to be used for service !!! (**service tools required !!!**)*
777	Calib. Syringe on/off	As required by user
881	Absorbance correction function (A-factor)	1.000
987	*allows to actuate valves*	*For service only*
999	Automatic Calibration / Span Calibration	As required

Remarks:

191: ***Tedlar-Bag-Mode*** is only used for instruments optionally equipped for this method to determine Hg in natural gas or other gas samples.

222: ***Zero offset***- for correction of the analytical zero value, this value is subtracted from the measurement peaks.
Temp offset- for correction of the offset of an automatic or manual calibration device.
Heating Flow: allows to set heating flow, **shall not be changed from standard setting** except for special applications (high measuring range).
Flow Regulate: For service purpose only, **shall not be changed from standard setting.**
If **"*Heating flow regulate= ON*"** then the pump is controlled by the mass flow meter signal within +/- 2 l/h of the set value.
If **"*Heating flow regulate= OFF*"**, then the pump is fed with a constant voltage (7.5 V) and the flow may vary within a range of +/- 3 l/h.
If the Flow is out of range, a ***Repeat Zero*** will be performed up to 10 times, after this the system will be halted and an error message will be displayed.

333: Shows the peak during System Evaluation when on; a horizontal line is displayed when off.

753: For calibration service of flow meter only!

777: Only on if an Automatic Calibration Unit is installed. Has to be on if an automatic calibration should be performed.

881: ***For service only!***

987: ***For service only!***; allows to actuate valves and status contacts.

999: Mode of automatic calibration can be selected: ***multiple point calibration*** or ***one point span calibration***.

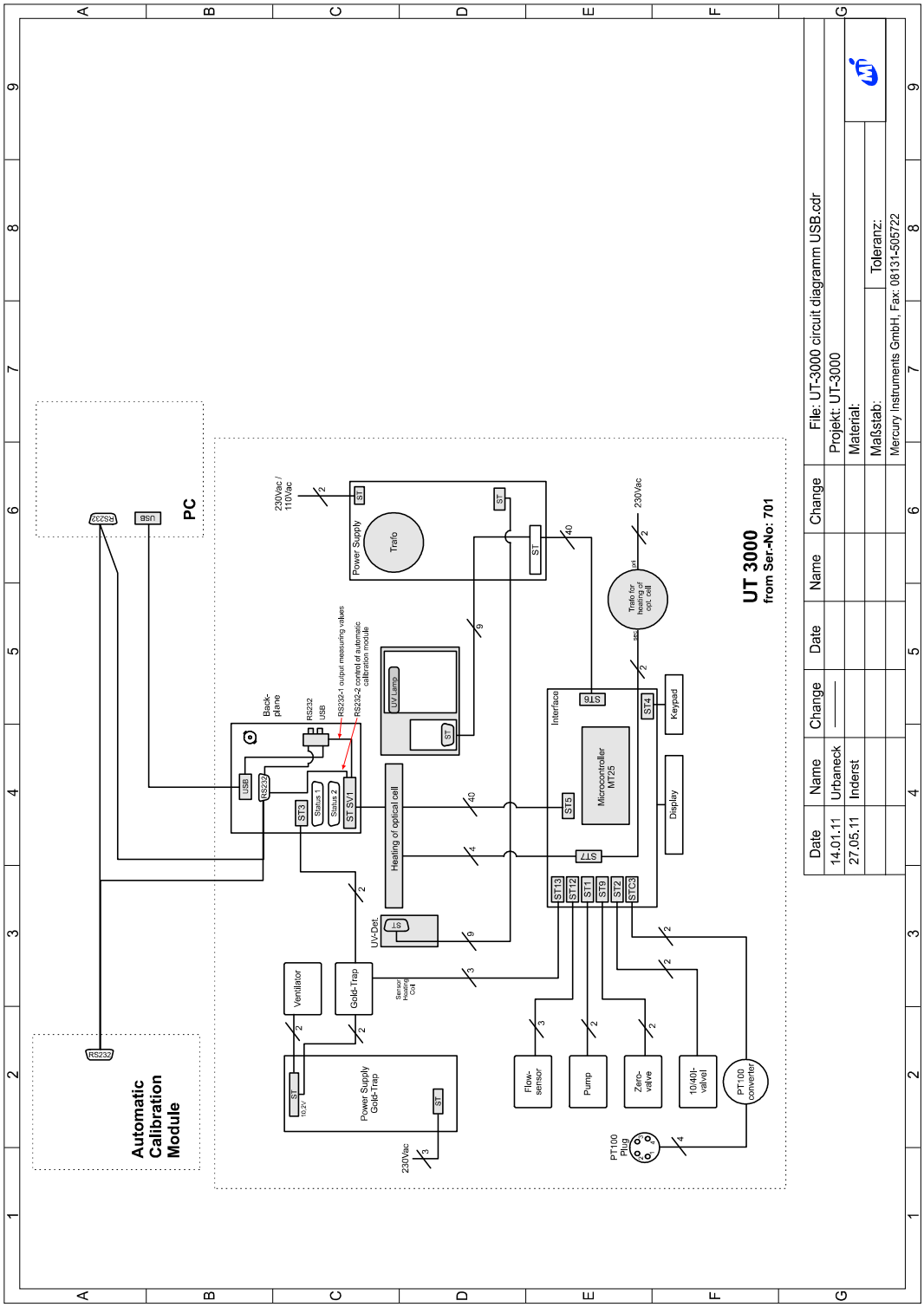
6. Maintenance

6.1 Spares and Accessories

ID #	Description of Part
101-07	Particulate filter F400
101-21	Particulate filter, small version
201-04	Activated carbon cartridge
203-02G	Optical cell
203-05	LC display
203-52	Microprocessor board
203-54	Detector module
203-61	UV lamp bulb (EDL)
505-38	Connector piece, for connecting UT-3000 and Auto Cal Unit
800-20	Sample bag, Tedlar, 10 l
800-25	Sample bag Tedlar, 3 l
810-01	Calibration set for manual calibration
810-02	Automatic Calibration Unit
810-10	Syringe, gas tight, 10 µl, for manual calibration
810-11	Capillary for 10 µl Syringe
810-12	Septa (pack of 10), 14 mm diam, for manual calibration set
810-13	Set of Septa (10 pcs), 6.5 mm diam, for UT-3000 Cal.Port
810-14	Ventilator for Automatic Calibration Unit
810-15	Syringe, gas tight, 25 µl, for Automatic Calibration Unit
810-16	PTFE piston for 25 µl syringe 810-15
810-17	Dryer cartridge, filled with desiccant, for Auto Cal Unit
810-18	Power supply, complete, for Automatic Calibration Unit
810-19	Closed cap for calibration cell
810-20	Septum cap for calibration cell
810-21	Saturation chamber, complete with insulating jacket
810-22	Peltier cooler block, complete with heat exchanger and Peltier element
810-62	Interface board
820-01	Protective and carrying case, for UT-3000 or Auto Cal Unit
830-01	Sample inlet dust filter, PTFE 0.25 µm, pack of 10
830-02	Valve, 2/3 way, for Goldtrap/Zeroing
830-03	Valve, 2/3 way, for heating/sampling flow
830-04	Electronic mass flow meter
830-06	Needle valve, brass, for sample flow adjustment
830-08	Needle valve, stainless steel, for heating flow adjustment
830-10	Pump, for sampling and heating gas flow
830-11	GoldTrap, complete with heating coil
830-12	Pt-100 converter module
830-14	Ventilator for UT-3000
830-15	Power supply, complete, for GoldTrap
830-16	Power supply board, for UT-3000

830-17	Calibration port, complete, stainless steel
830-20	Holder for GoldTrap, incl. electronics
830-24	Particle filter, 60 µ; stainless steel
830-95	Tubing, complete set
830-96	Fuse set
830-98	Service kit
840-02	Pressure relief valve
840-03	T-joint
840-04	Backplane USB with 40p flatband-connection to interface board

6.2 Technical drawings



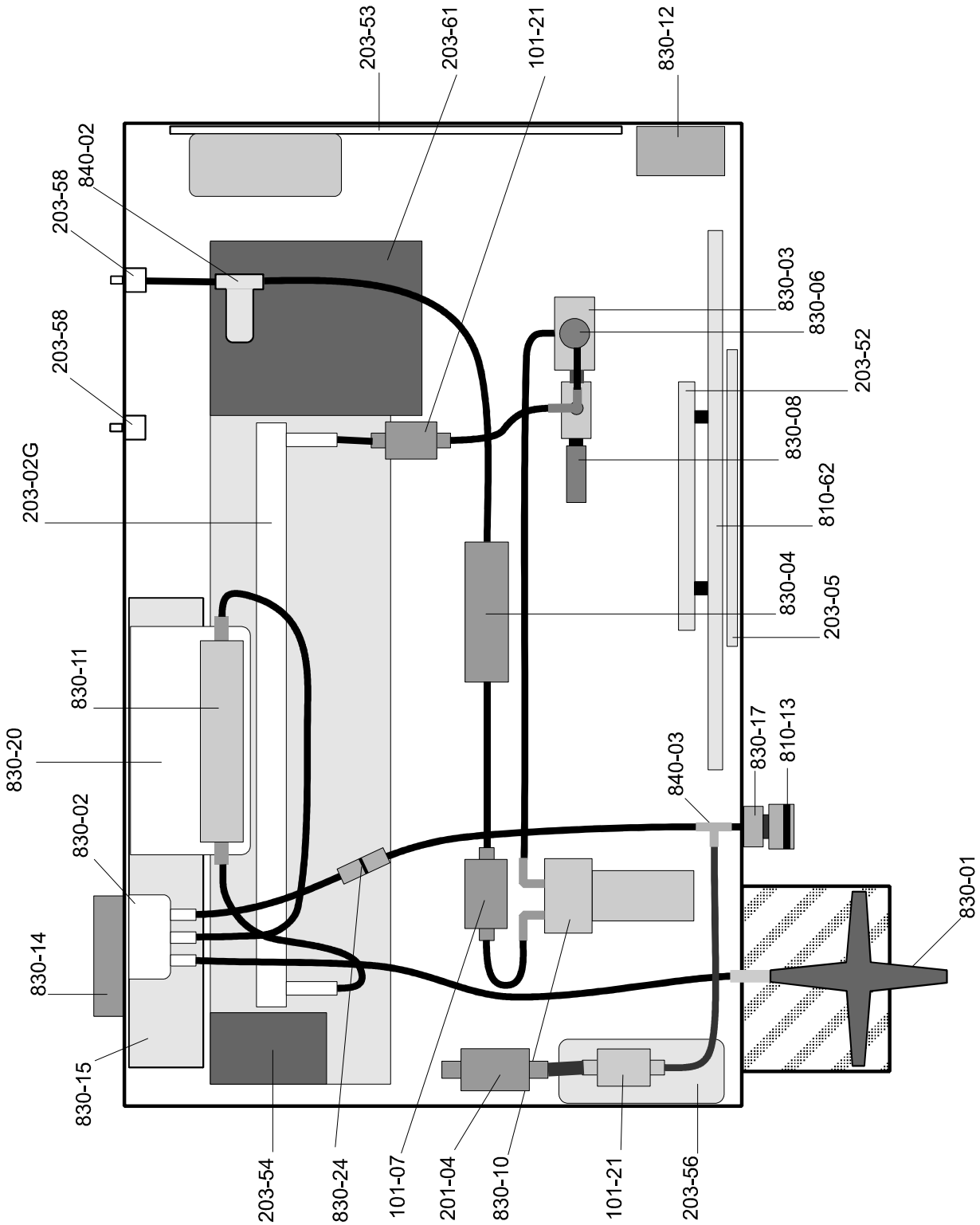
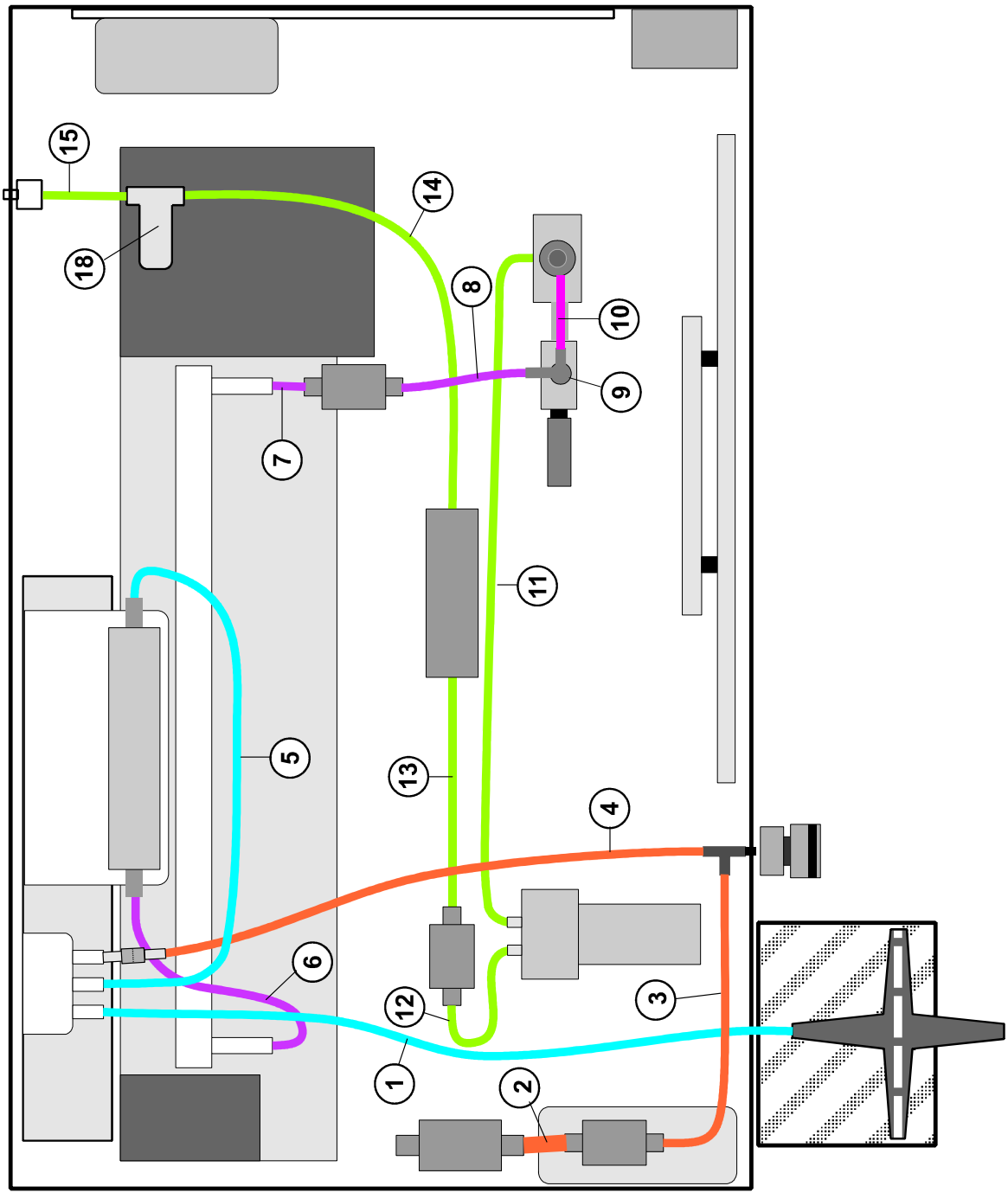


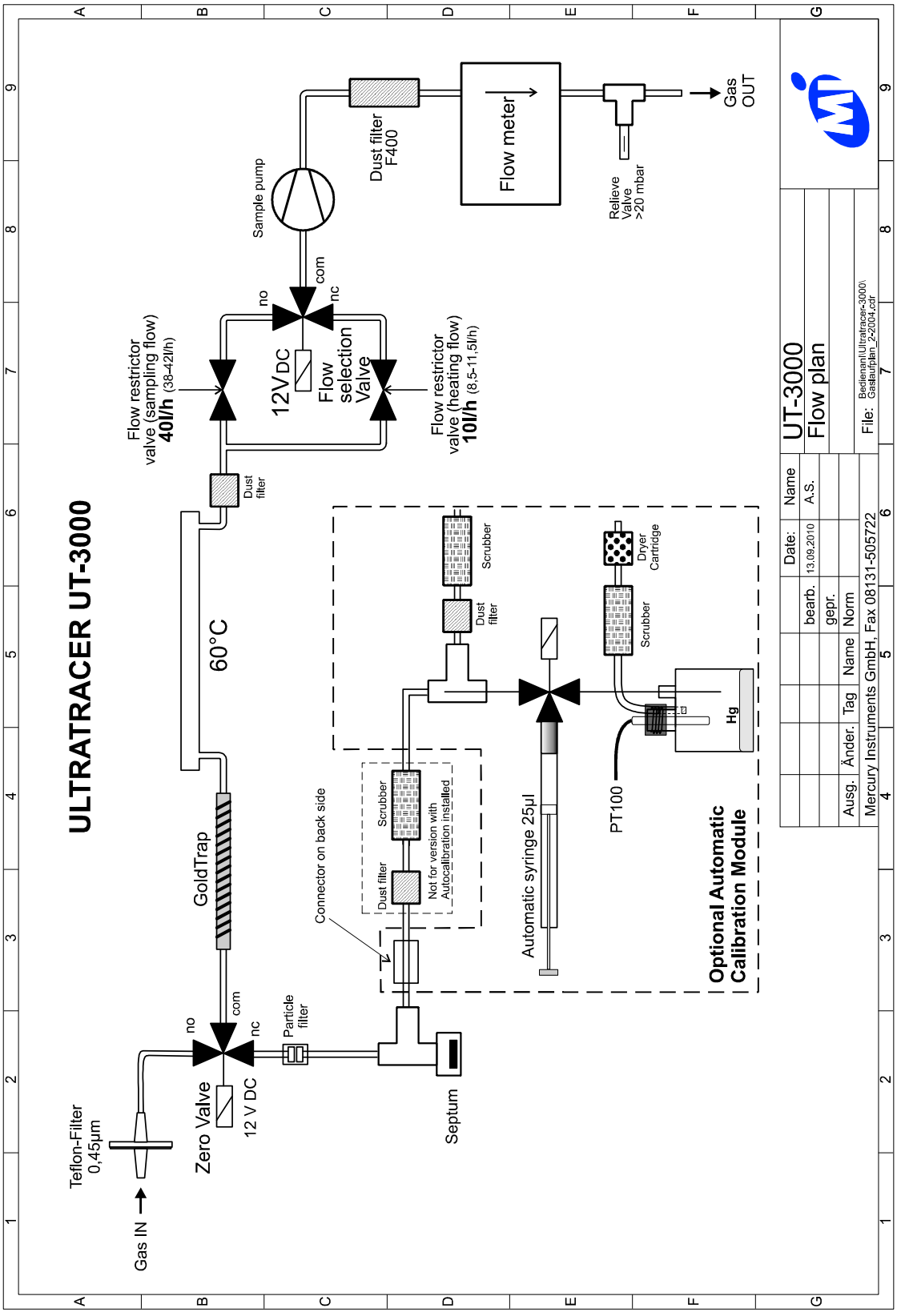
FIGURE: UT-3000 ID-NUMBERS OF PARTS

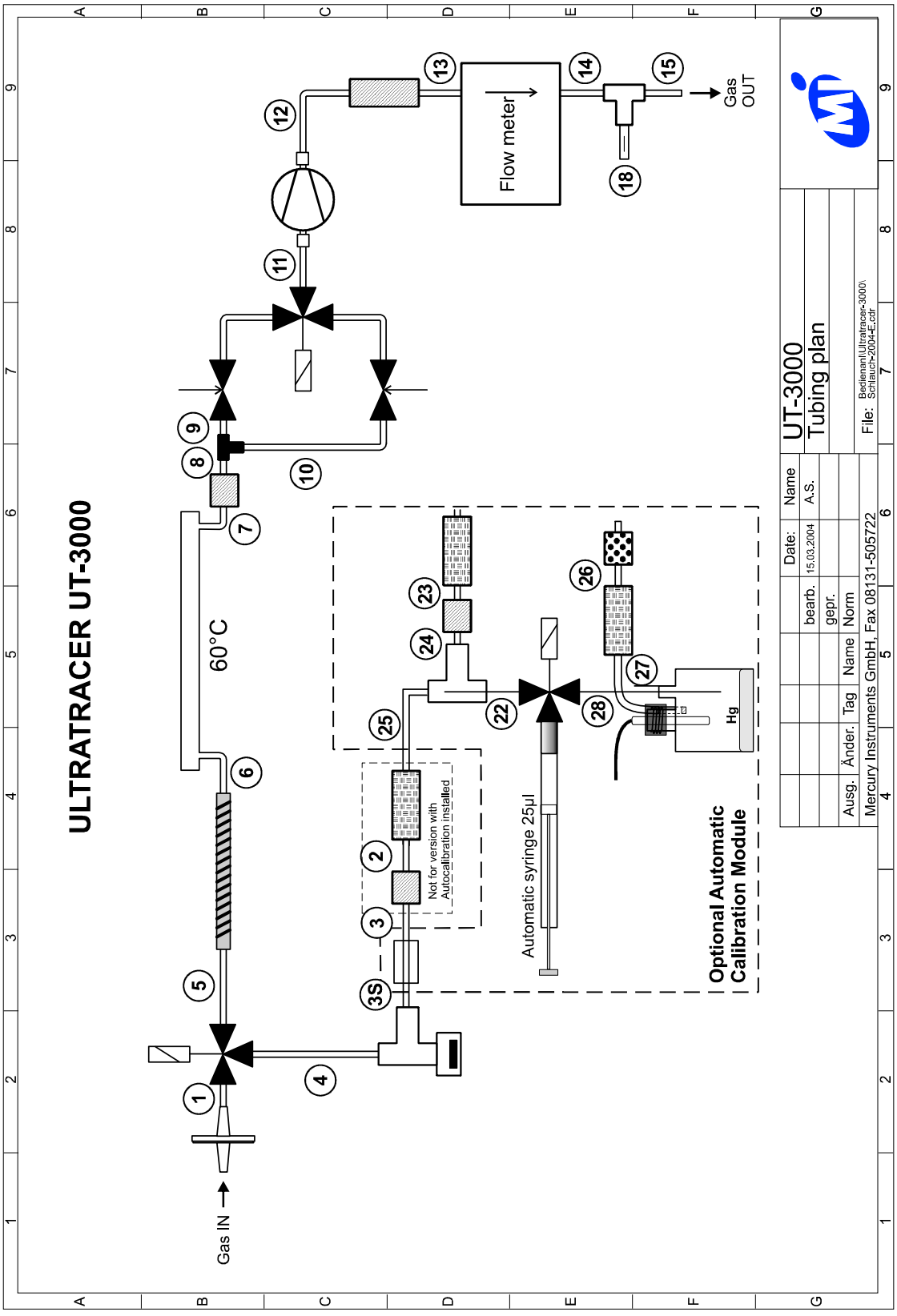


UT-3000: ID-NUMBERS OF TUBING

REMARKS: 1. FOR TEDLAR BAG VERSION TUBING NO. 14 IS REPLACED BY TUBING NO.14T AND TUBING NO. 15 IS OMITTED.

2. FOR VERSION WITH AUTOMATIC CALIBRATION UNIT TUBING NO. 2 AND 3 INCLUDING COMPONENTS NO. 101-21/201-04 (WHICH ARE PLACED IN THE AUTOMATIC CALIBRATION UNIT) ARE REPLACED BY TUBING NO.3S


ULTRATRACER UT-3000
Gas IN
Teflon-Filter 0,45µm
Zero Valve
12 V DC
no
com
nc
Particle filter
Septum
GoldTrap
60°C
Dust filter
Flow restrictor valve (sampling flow) 40l/h (38-42l/h)
Flow restrictor valve (heating flow) 10l/h (8,5-11,5l/h)
12VDC
Flow selection Valve
Sample pump
Dust filter F400
Flow meter
Relieve Valve >20 mbar
Gas OUT
Connector on back side
Scrubber
Not for version with Autocalibration installed
Automatic syringe 25µl
PT100
Dryer Cartridge
Hg
Optional Automatic Calibration Module
UT-3000
Flow plan
Name
A.S.
Date:
13.09.2010
bearb.
gepr.
Norm
Ausg.
Änder.
Tag
Name
Mercury Instruments GmbH, Fax 08131-505722
File: Bedienanl\Ultratrace-3000\Gaslaufplan_2-2004.cdr


ULTRATRACER UT-3000
60°C
Flow meter
Gas OUT
Gas IN
Automatic syringe 25µl
Not for version with Autocalibration installed
Optional Automatic Calibration Module
Hg
UT-3000
Tubing plan
Mercury Instruments GmbH, Fax 08131-505722
Name A.S.
Date: 15.03.2004
bearb.
gepr.
Norm
Name
Tag
Änder.
Ausg.
File: Bedienan\Ultratrace-3000\Schlauch-2004-E.cdr

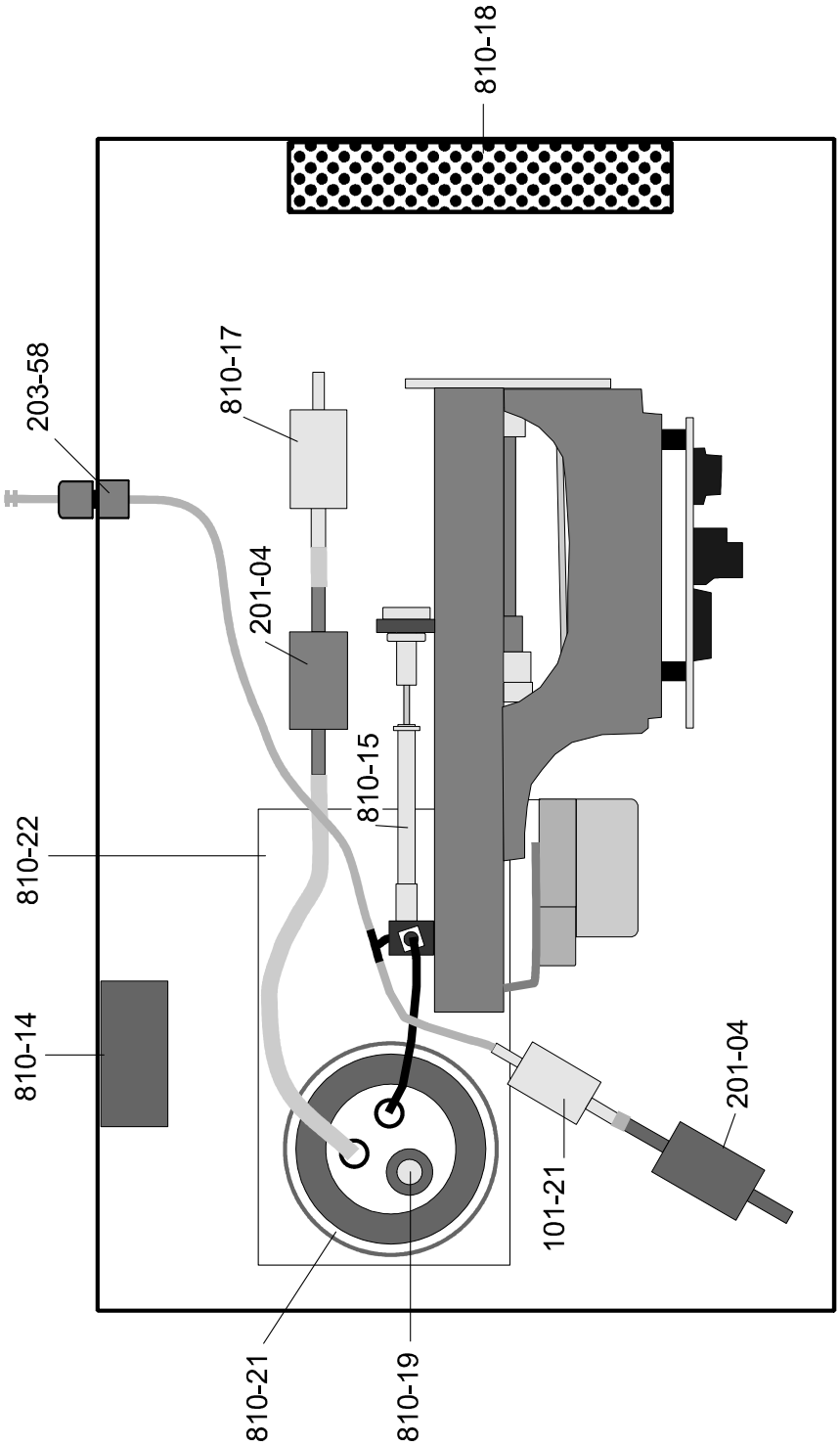


FIGURE: AUTOMATIC CALIBRATION UNIT, PART NUMBERS SEE SPARE PARTS LIST CHAPTER 8.4

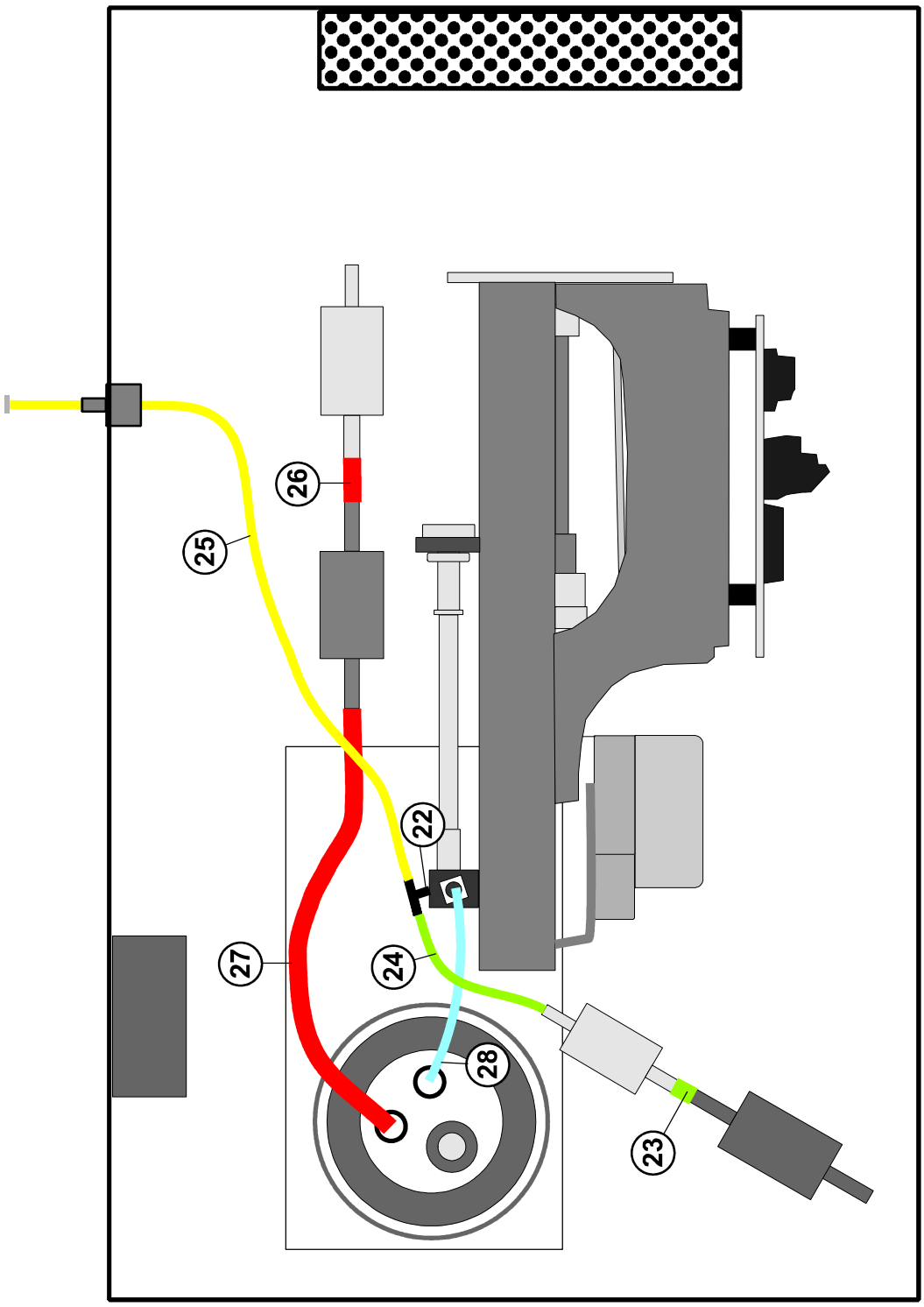


FIGURE: AUTOMATIC CALIBRATION UNIT, ID-NUMBERS OF TUBING

6.3 Error messages

6.3.1 Lamp !

The installed electrodeless mercury lamp is monitored permanently. If its performance drops under a certain limit the warning „**LAMP**!" indicates that it should be replaced within the next days.

6.3.2 Sampling Flow out of Range!

This warning appears if the flow during sampling is out of the allowed range (38 – 42 l/h).
Possible reasons:

a) sample gas inlet filter plugged up

b) pump defective

c) needle valve for sample flow adjustment plugged up

→ Check filters, check if pump operates, re-adjust sampling flow (**Chapter 6.9**)

6.3.3 Heating Flow out of Range!

This warning appears if the flow during thermal desorption is out of the allowed range (8.5 – 11.5 l/h).
Possible reasons:

a) GoldTrap plugged up

b) pump defective

c) needle valve for heating flow adjustment plugged up

→ Check filters, check if pump operates, re-adjust heating flow (**Chapter 6.9**)

6.3.4 Temp. out of range ! See instruction manual!

This warning indicates, that the temperature of the connected calibration device is out of its specified range.

6.3.5 Check heating coil !

This warning indicates, that the magnetic field sensor for the GoldTrap heating coil control has detected, that no current is passing the heating coil. Cause may be a burnt coil or a defective power supply.

6.3.6 T-Sensor not connected ! Connect T-Sensor of Calibration Cell!

This warning indicates, that the PT100 temperature sensor of a manual or automatic calibration unit is not connected.

6.3.7 Temp out of Range ! See instruction manual!

This warning indicates, that during calibration with a connected manual or automatic calibration device the temperature is <6°C or >35°C.

6.3.8 Pump ! (flashing)

This warning indicates, that the flow counter is out of range (1-100 is correct) and pump voltage is at its upper limit (12V)! Reason may be a malfunction of the pump, plugged valves 830-08 or 830-03, not correctly adjusted valves 830-08 or 830-03.

6.3.9 Lamp Stability!

This warning indicates that the UV lamp (which is checked during the last seconds of zeroing) is unstable and needs to be checked by the service.

6.3.10 Logger full (flashing)

This warning indicates, that the remaining capacity of the data logger memory is zero.

6.3.11 No Sample!!!

This warning is for the NG (Natural Gas) version only. In case that no sample gas is delivered to the sample inlet (for example sample line has been closed) this message warns the user. Twenty seconds after sampling has started the flow is measured. If the Sampling Flow is then below approx. 6 - 7 l/h the system automatically switches to zero air and counts down for one hour before restarting measurement automatically.

6.3.12 EEP INIT; Warning No. 20: Check Parameters! See Instruction Manual!

This warning indicates, that the EEPROM has been reset. Parameters (calibration, sample volume, …) have to be checked and re-entered in case they have been lost.

6.3.13 Warning No. 50: Check Calibration! See Instruction Manual!

This warning indicates, that the last calibration has been erased; a new calibration has to be performed or entered in the service menu.

6.3.14 Warning No. 60: Check Flow-Calibration ! See Instruction Manual!

This warning indicates, that the calibration of the flow meter has been erased; the parameters for the flow calibration have to be entered in the service menu or the flow meter has to be re-calibrated (by service).

6.3.15 Warning No. 70; Check Calibration Data!

This warning indicates that the data of the last automatic calibration have been erased. A new calibration has to be performed or manually entered in the service menu.

6.3.16 Warning No. 80; RS232 Communication Error; Connect Syringe!

This warning indicates, that a communication error between UT-3000 and the automatic calibration module has occurred.

6.3.17 Warning No. 91; Check Calibration!

This warning indicates, that the parameters of the calibration are out of the feasible range: slope should be between 0.00002 … 0.00015, offset should be between –0.001 … +0.001.

6.3.18 Repeat Zero

This warning indicates that the flow during Zeroing is out of range (< 8 l/h; > 12 l/h).

6.3.19 Low Sampling Flow

For UT-3000 with NG (natural Gas) software only!
This warning indicates, if a sample is measured from Tedlar Bag (Tedlar function in Service menu, Code 191, =ON), that the sample flow is lower than 20 l/h.

6.4 Troubleshooting

6.4.1 Unusual Measuring Peaks

An example for a non-typical peak is shown in the picture below.
The peak is more of triangular shape and the signal drops to negative values after the peak.

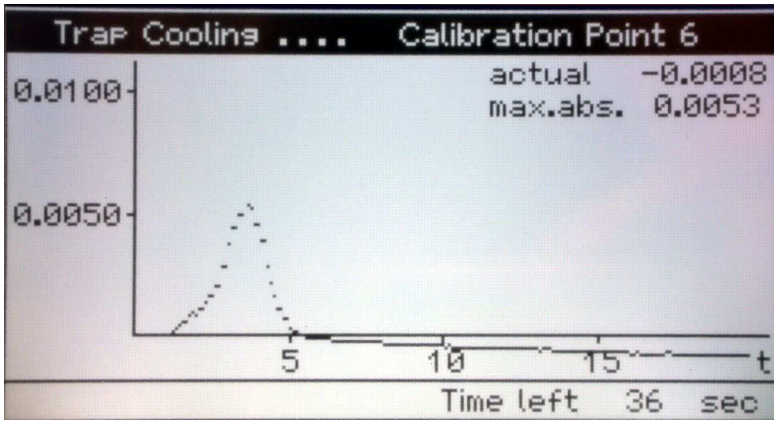


Figure: Example for an non-typical desorption peak

The reason may be precipitation in the tubing at the outlet of the GoldTrap (= tubing which connects GoldTrap and optical cell, see picture below).
In this case it is recommended to replace the contaminated tubing.

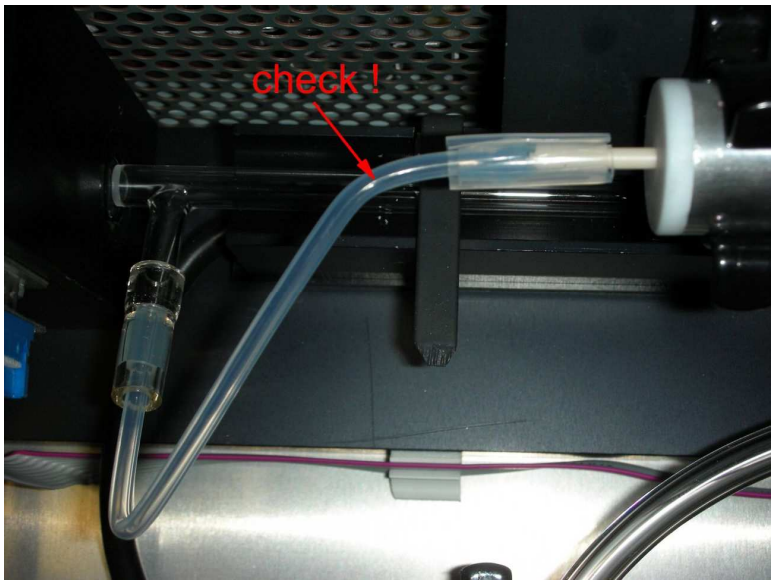


Figure: Tubing at outlet of GoldTrap. The arrow indicates the position where precipitation might occur.

6.5 Routine Maintenance

6.5.1 Replacement of Membrane Filter

Under normal circumstances the sample membrane filter has to be inspected regularly. If a deposit of particulate matter or staining is visible, the filter has to be replaced. For filter replacement, turn the filter slightly and pull it out. Insert the new filter into the filter holder and push it carefully over the white nozzle in the centre of the filter holder. Turn the filter slightly.

6.5.2 Replacement of the filter cartridges

A) UT-3000 Unit

Inside the instrument there are two filter cartridges: one activated carbon cartridge and one particulate filter cartridge. These should be replaced annually.

First loosen the two screws in the back of the UT-3000 photometer unit and remove top cover of the case. Do not pull with force as a ground wire is mounted to the cover. The ground wire can be disconnected by pulling the plug on one end. The filter cartridges are now visible and can be removed from their holding clamps. To replace the cartridges, the connected hose has to be pulled off.

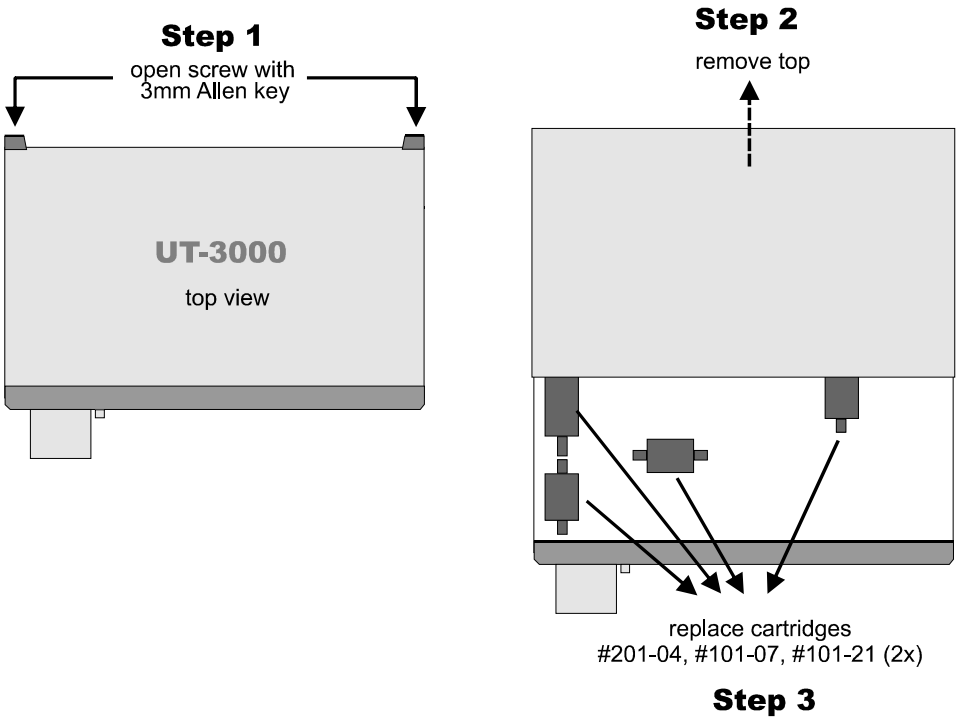


FIGURE: OPENING OF THE TOP COVER OF THE INSTRUMENT AND REMOVING THE CARTRIDGES OF THE UT-3000

B) Automatic Calibration Unit (option)

Inside the Automatic Calibration Unit there are four filter cartridges: two activated carbon cartridges, one particulate filter cartridge, and one desiccant cartridge. These should be replaced annually.

First loosen the two screws in the back of the Automatic Calibration Unit and remove top cover of the case. Do not pull with force as an ground wire is mounted to the cover. The ground wire can be disconnected by pulling the plug on one end. The filter cartridges are now visible and can be removed from their holding clamps. To replace the cartridges, the connected hose has to be pulled off.

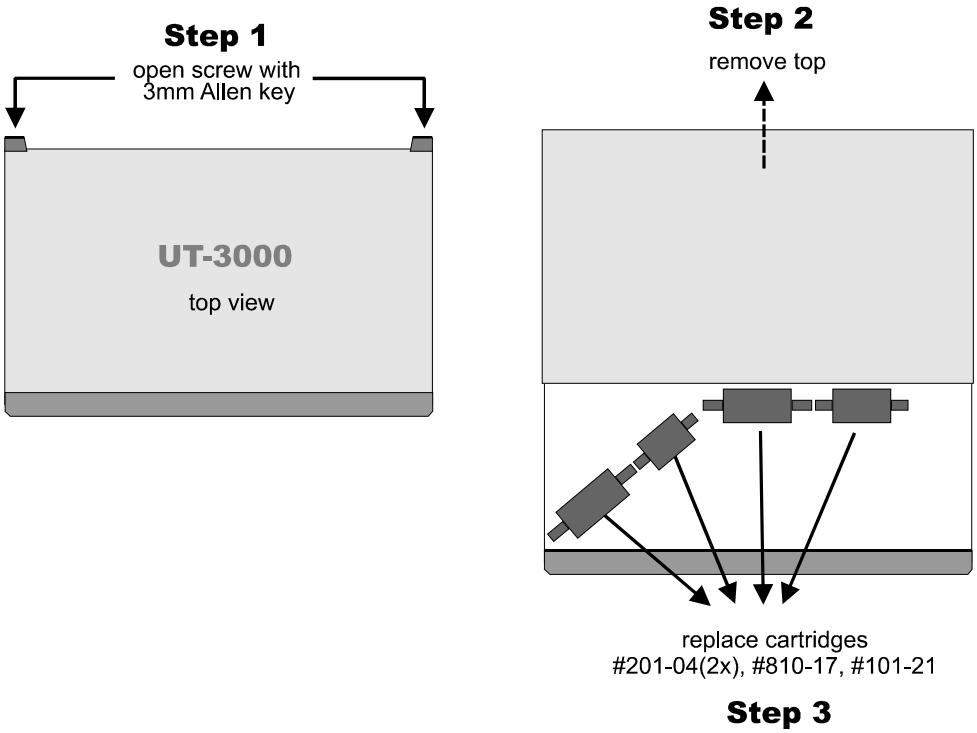


FIGURE: OPENING OF THE TOP COVER OF CALIBRATOR AND REMOVING THE CARTRIDGES

6.6 Fuses

The main fuse compartment is located on the rear of the instrument between the power cord receptacle and the power switch. It contains two fuses.

Pull power plug before opening the fuse compartment!

Fuse type: the rating of the fuses to be used as spares depends on the operation voltage indicated on the rating plate of the instrument:

230V Operation voltage: Fuse type T 1.6 A (time lag)
115V Operation voltage:

A third fuse (3.15 A medium time lag) is located on the power supply board inside the photometer. It can be changed after opening the cover of the instrument.

Pull power plug before opening the photometer!

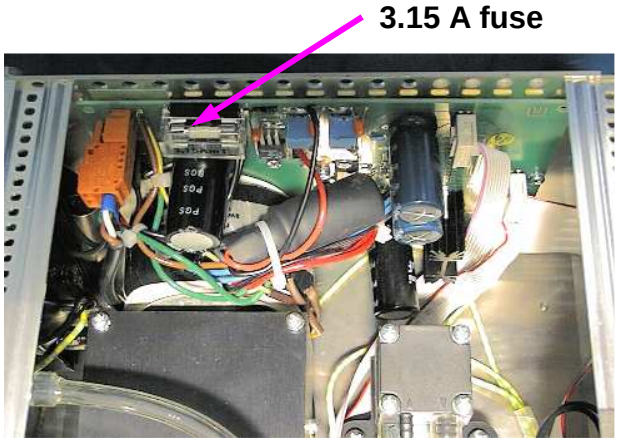


FIGURE: POWER SUPPLY BOARD INSIDE PHOTOMETER

The **Automatic Calibration Unit** has two main fuses which are located in the fuse compartment. This is located on the rear of the instrument between the power cord receptable and the power switch.

Pull power plug before opening the fuse compartment!

Fuse type: The rating of the fuses to be used as spares depends on the operation voltage indicated on the rating plate of the instrument:

230V Operation voltage: Fuse type T 1.0 A (time lag)
115V Operation voltage:

6.7 Cleaning the GoldTrap

In some cases the sensitivity of the analyzer may be clearly reduced compared to the new instrument and the measurement signal gets weak. One reason for this may be a contamination of the GoldTrap. One may try to remove this contamination by rinsing the inside of the GoldTrap with concentrated nitric acid.

WARNING: Nitric acid is a toxic, harmful, dangerous and corrosive reagent. Only personnel which has been sufficiently trained in working with such chemical substances is allowed to handle nitric acid and to perform the following steps!

Concentrated acids shall be handled in a fume cupboard!
Protective laboratory clothes, safety goggles and laboratory gloves have strictly to be worn!

The GoldTrap has to be uninstalled following the steps in chapter 7.6. Over both ends of the thin ceramic tube which poke out from the aluminium cylinder a suitable plastic tubing (PVC, Tygon®) is pushed so that a tight connection is formed. The plastic tubing on one end shall be long enough to reach the bottom of a 50 ml or 100 ml glass beaker. The plastic tubing on the other end is connected with the tip of a plastic syringe (a 10 ml medical syringe will work). Approximately
20 ml of concentrated nitric acid are filled into the glass beaker (fume hood!). The GoldTrap-Syringe assembly is positioned over the beaker so that the free end of the tubing dips into the nitric acid. The piston of the syringe is pulled carefully and slowly so that nitric acid is sucked through the GoldTrap and appears in the syringe. After waiting for approximately 30 seconds the acid is pushed through the GoldTrap the other direction by pushing the piston of the syringe. Care has to be taken that no acid splashes out from the beaker.

After this the GoldTrap-syringe assembly is carefully removed from the beaker with nitric acid and the open end of the plastic tube is immersed in a beaker with filled with water. The water is pulled into the syringe thus rinsing the GoldTrap and removing the nitric acid. After that the GoldTrap-syringe assembly is removed from the water filled beaker and placed over a sink or a suitable container which shall hold the purge water (= acidic water). By pressing the piston of the syringe the rinse water is released from the GoldTrap. This rinsing step is repeated at least five times in order to remove any salts or acids. Then the GoldTrap is disconnected from the syringe and all tubing is removed. It has to be dried with a flow of nitrogen or clean air before it is installed into the instrument again.

CAUTION: the acid used for cleaning must only be in contact with the interior of the thin ceramic tube in the center line of the GoldTrap and must never get into contact with the cylindrical aluminium part or with the coil inside the aluminium cylinder or with the connection cables and plug. This will damage the GoldTrap within a short time!

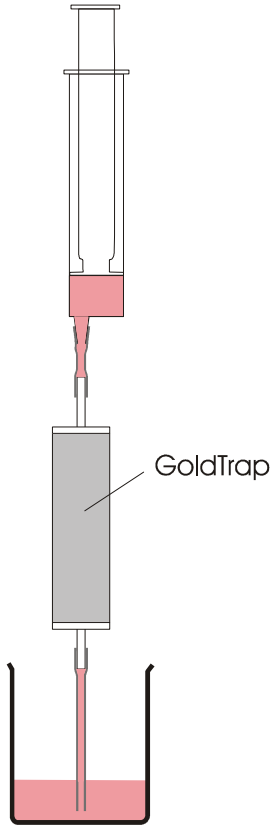


FIGURE: CLEANING OF THE GOLDTRAP WITH NITRIC ACID

6.8 Replacement of the GoldTrap

The GoldTrap requires replacement if the slope of the calibration curve is below 0.00004. A new GoldTrap (part No. 830-11) will be inserted instead of the used one which may be returned to the manufacturer for regeneration.

Pull power plug before opening the photometer!

First loosen the two screws in the back of the UT-3000 photometer unit and remove top cover of the case. Do not pull with force as an ground wire is mounted to the cover. The ground wire can be disconnected by pulling the plug on one end. The GoldTrap is now visible.
Identify the power supply cable of the GoldTrap and disconnect it by pulling the small plug. Carefully disconnect the tubing at the gas inlet and gas outlet of the GoldTrap (see picture below). Try to push the end of the tubing with fingernails instead of pulling the tubing. Try to balance force to both sides of the GoldTrap and avoid to pull the thin brown coloured ceramic tube to one side, it should always stay centred.
After the plug and the tubing have been disconnected the GoldTrap can be removed from its holding clamps and the new GoldTrap can be inserted. After that the tubing are connected to the GoldTrap again and the cable is plugged in.

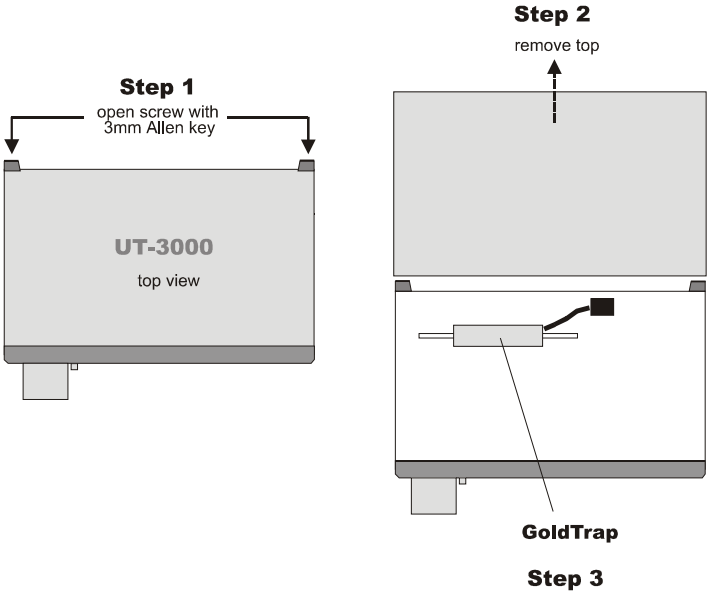
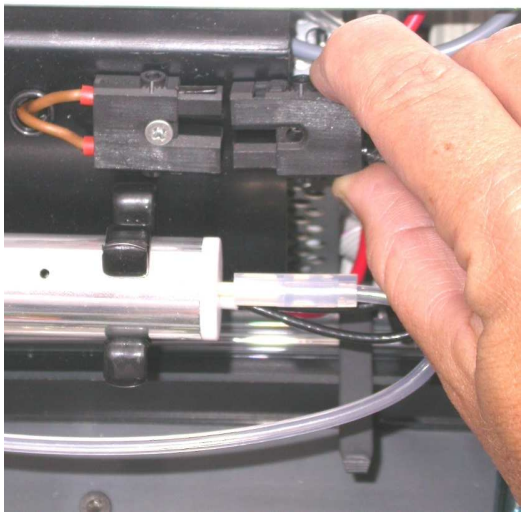


Figure: opening of the top cover of the instrument and position of GoldTrap



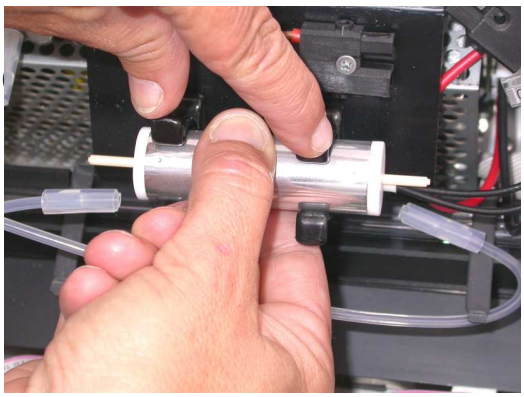


FIGURE: DEINSTALLATION OF GOLDTRAP:
(LEFT UP) REMOVING THE PLUG
(RIGHT UP) REMOVING THE TUBING

6.9 Flow Adjustment (for qualified personnel only)

After replacement of components which may influence the flow (GoldTrap, filters, pump) it may be necessary to readjust the flow. Select from the Service Menu→ Show Flow (see chapter 5.3).

6.9.1 Heating Flow Adjustment

Read Heating Flow
Select F1- Heating Flow. Allow to stabilize for approximately one minute. The actual flow will be indicated on the screen and should be between 9.8 l/h and 10.2 l/h. In the right bottom corner the pump voltage will be displayed. It should be in the range of 6.5 … 10.0 Volts, optimum 7-8 Volts.

Maintenance work on the opened and powered instrument must only be done by qualified personnel.
Parts of the instrument interior are under high voltage. UV-beams are produced inside the instrument. If safety regulations are ignored physical and/or material damages could occur.

Adjust Heating Flow
If adjustment is necessary, open the instrument cover (read warning above !) and adjust by slowly turning the horizontally positioned setting knob of needle valve 830-08. Turning the knob to the left will decrease the voltage. Turn until voltage is in the desired range and observe if flow is in the range of 9.7 … 10.3 l/h.

6.9.2 Sampling Flow Adjustment

Read Sampling Flow:
Select F2- Sampling Flow. Allow to stabilize for approximately one minute. The actual flow will be indicated on the screen and should be between 39.7 l/h and 40.3 l/h. In the right bottom corner the pump voltage will be displayed. It should be in the range of 6.5 … 10.0 Volts, optimum 7-8 Volts.

Maintenance work on the opened and powered instrument must only be done by qualified personnel.
Parts of the instrument interior are under high voltage. UV-beams are produced inside the instrument. If safety regulations are ignored physical and/or material damages could occur.

Adjust Sampling Flow
If adjustment is necessary, open the instrument cover (read warning above!) and adjust by slowly turning the vertically positioned setting knob of needle valve 830-06. Turning the knob to the left will decrease the voltage. Turn until voltage is in the desired range and observe if flow is in the range of 39.7 … 40.3 l/h.

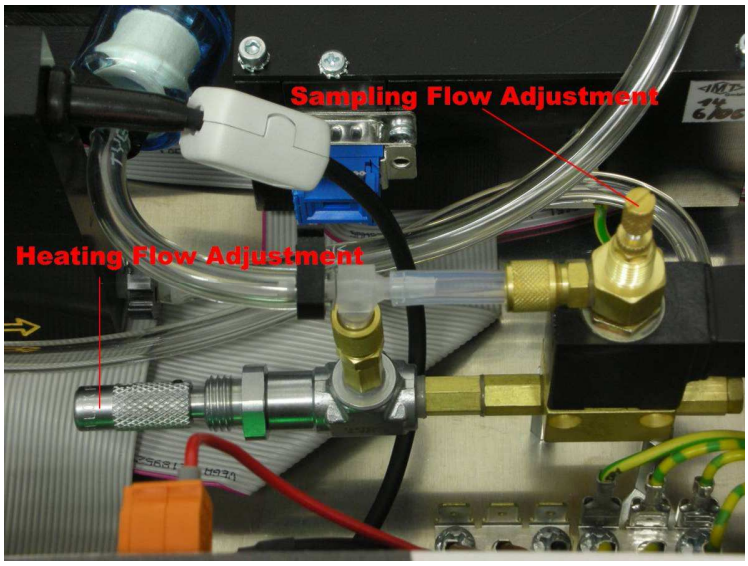
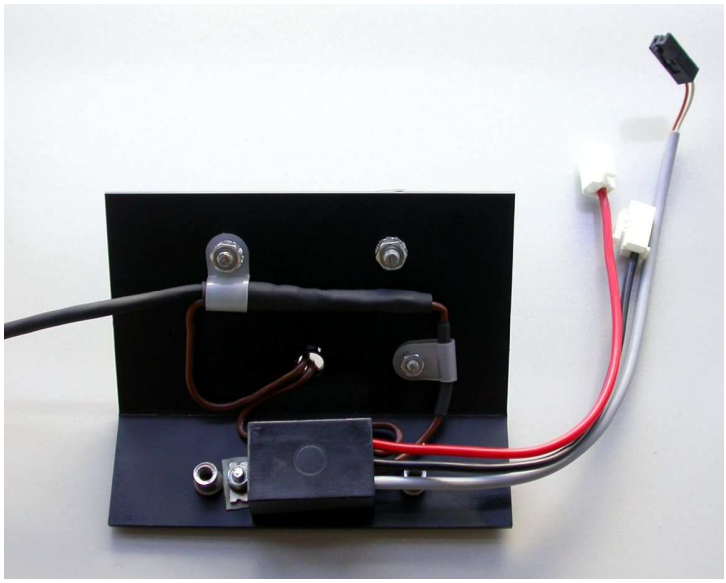


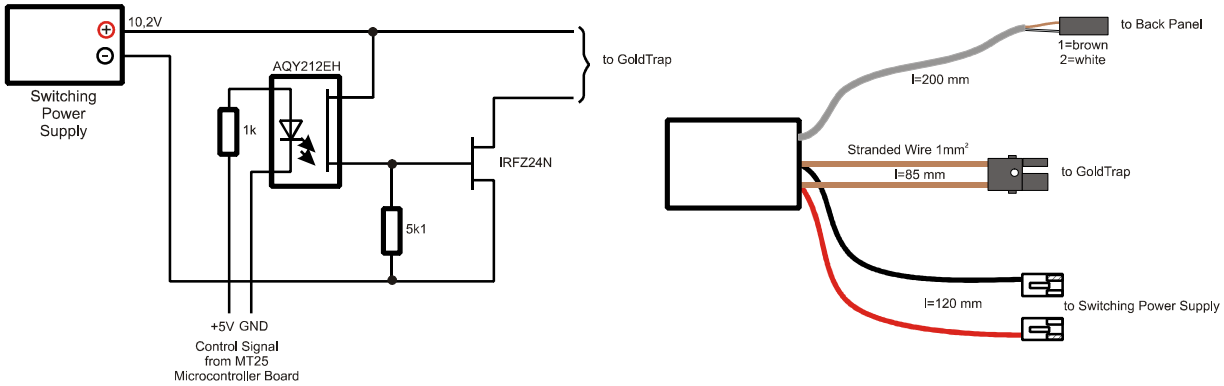
FIGURE: NEEDLE VALVES FOR HEATING FLOW ADJUSTMENT AND SAMPLING FLOW ADJUSTMENT

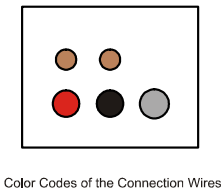
6.10 Gold Trap Assembly

The GoldTrap is snapped into holding clamps which are mounted on an angled metal plate. This plate holds following electronic parts on its down side:

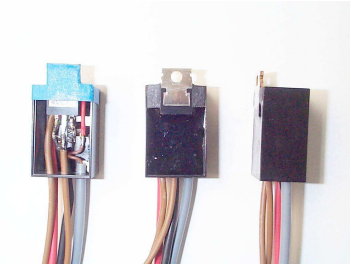
(a) A driver transistor that switches the power for the heating coil of the GoldTrap,
(b) An optical coupler,
(c) Two resistors.







Color Codes of the Connection Wires



7. Technical Information

7.1 Technical specifications

Instrument type	UT-3000
Manufacturer	Mercury Instruments GmbH, Liebigstr. 5, 85757 Karlsfeld, Germany
Measuring component	Total Gaseous Mercury (TGM)
Measurement principle	Atomic absorption, cold vapor method, Preconcentration with GoldTrap
Measurement wavelength	253.65 nm
UV-source	electrodeless mercury discharge lamp
Method of stabilising	optically with reference beam; thermally
Optical cell	entirely of fused silica Suprasil, l= 230 mm
Cell temperature	ca. 70 °C, heated
Measuring range a) lowest range b) medium range c) screening mode	0.1 ng/m³-1000 ng/m³ at 10 l sample volume 1 ng/m³-3000 ng/m³ at 1 l sample volume 10 ng/m³ - 30000 ng/m³ at 0.1 l sample volume
Detection limit according DIN 32645	1 pg absolutely or 0.1 ng/m³
Linearity over the 0.2 to 15000 ng/m³ range	1.5 % or better
Reproducibility	5 % or better at 14 pg Hg 1 % or better at 1500 pg Hg
Sampling flow	40 l/h
Goldtrap heating flow	10 l/h
Digital output signal	Serial (USB/RS 232) for PC connection,
Data logger capacity	5000 data sets
Electrical power consumption	Photometer: max. ca. 250 VA Calibration Unit: ca. 70 VA
Power supply	230 VAC / 50 Hz ; 115 VAC / 60 Hz (option) ; 12 V DC (option)
Dimensions	45 x 15 x 35 cm (WxHxD) without filter
Weight	ca. 12 kg

7.2 Influencing effects

Operating temperature	0 °C ... 40 °C
Operating humidity	max. ca. 90 % R.H., no condensing humidity
CE approval	according to 89/336 and 73/23 EEC

7.3 Storage and transport

The interior of the UT-3000 and the calibration device should be kept save from moisture and hard shocks. Vibrations caused by transport in a car do not harm the UT-3000.

- ☞ The **Automatic Calibration Unit** and the **Manual Calibration Unit** must always be carried or transported horizontal, it must never be tilt or turned over. Hard shocks must be avoided.
- ☞ In case of damage that leads to a mercury spillage observe the material safety data sheet in the appendix. Consult an expert!

8. Version for Hg determination in natural gas and other hydrocarbon gases (Tedlar® Bag Version)

A special version of the UT-3000 analyser can be used for measurement of mercury in natural gas and derivatives. For these applications special precautions have to be made to prevent explosion. The appropriate safety regulations have strictly to be observed. This instrument must not be operated in hazardous areas. Customized versions are available for installation in an hazardous area, contact the manufacturer.

FIGURES: PLANTS FOR NATURAL GAS PRODUCTION. SPECIAL UT-3000 SETUP ALLOWS TO MEASURE HG CONTINUOUSLY OR MANUALLY.

8.1 Sampling system for mercury determination in natural gas

The **Natural Gas Sampling System** is dedicated for taking a sample stream from a pressurized natural gas source. This source may be a storage tank or a pipeline containing or conducting compressed natural gas. The sample can be filled into a special sample bag (Tedlar bag) and carried to the analyzer. Sample bags come as accessories with the UT-3000 Mercury Ultratracer.

The **Natural Gas Sampling System** reduces the primary high pressure of the sample source (up to 200 bar) to a pressure below 1 bar so that the gas can be filled into a sample bag or fed to a continuously operating analyzer (for example the UT-3000 Mercury Ultratracer). Pressure reduction is performed with a high precision pressure regulator. To avoid condensation due to the Joule-Thompson effect the pressure regulator is electrically heated. Especially for mercury analysis it is important to precondition all surfaces of the system which come into contact with the sample. To guarantee a suitable preconditioning the sampling system has a bypass stream at the low pressure side. The bypass flow may be adjusted with a needle valve. The bypass flow is indicated by a flow meter. With a ball valve at Sample IN the sampling system can be isolated from the gas source. A second ball valve allows closing the outlet sample flow. In order to avoid ingress of water droplets or aerosols into the sample bag or analyzer a special coalescing filter is installed in the sample stream.

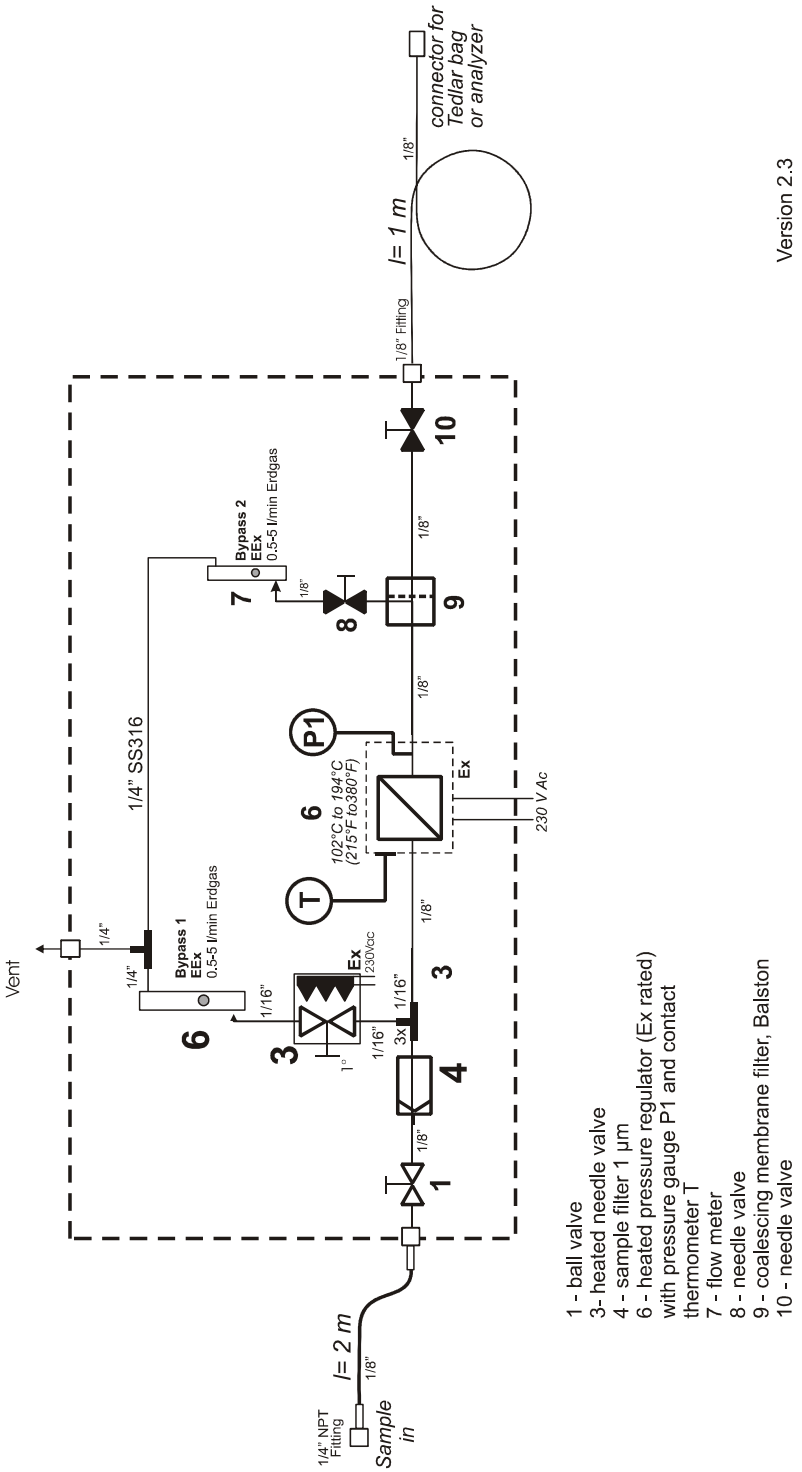


Figure: Natural Gas Sampling System
schematic gas flow

FIGURE: NATURAL GAS SAMPLIN SYSTEM
FRONT VIEW

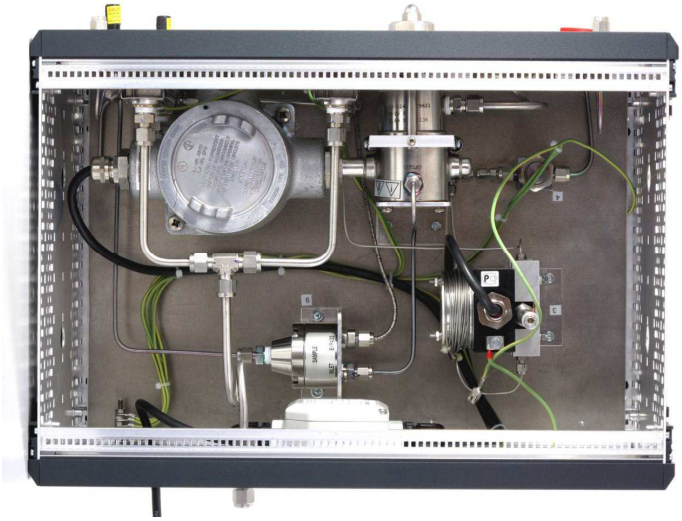


FIGURE: NATURAL GAS SAMPLING SYSTEM
TOP VIEW, OPENED

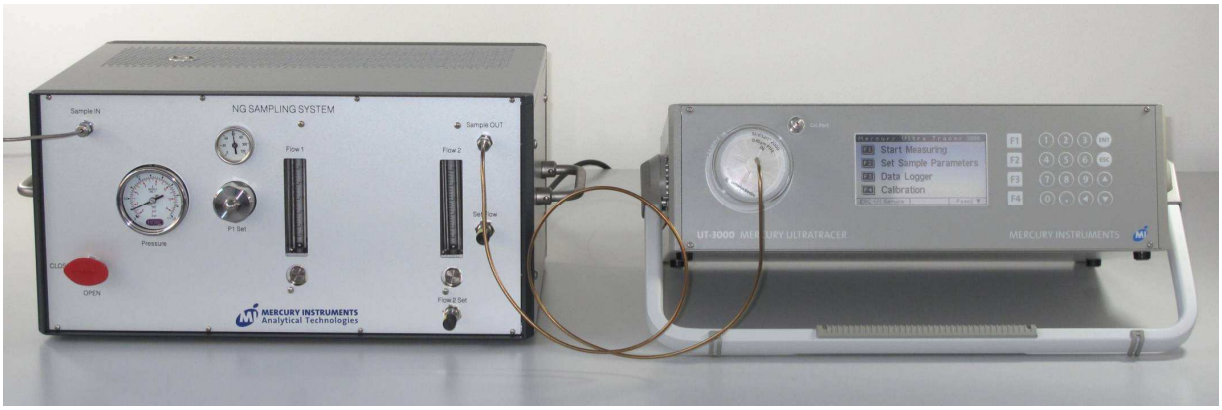


FIGURE: SETUP OF SAMPLING SYSTEM AND UT-3000 ANALYZER FOR HG MEASUREMENT FROM A SAMPLE CYLINDER

FIGURE: SAMPLING CONTINUOUS SAMPLING OF NATURAL GAS
(BENCHAMAS OFFSHORE PLATFORM; THAILAND)

8.2 Setup for continuous measurement of Hg in natural gas

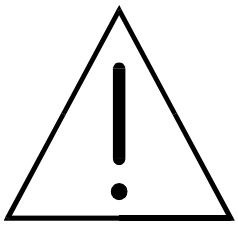
For automatic 24 hours per day monitoring an optional setup for continuous measurement is available. The analyser system is installed in a safe place out of the hazardous zone. The sample is extracted from the gas pipeline with a heated sampling system (described under 8.1. The sample is then guided to the analyser through a stainless steel/Teflon (PFA) capillary. The analyser is purged with air to avoid formation of an explosive atmosphere in case of leakage. In addition a built in gas sensor shuts the system down and stops the sample gas flow by closing a valve which is installed in the sample line.

8.3 UT-3000 version for analysis using a sample bag (Tedlar® Bag)

NOTE: the Tedlar Bag Method described in this chapter requires the corresponding software which is installed as an option. The Tedlar Bag Method has to be activated in the Service Menu by entering the Code 191 (see also Chapter 5.10).

The bag sampling technique offers a simple, low cost and yet precise method to determine the mercury concentration in natural gas (or other gas samples).

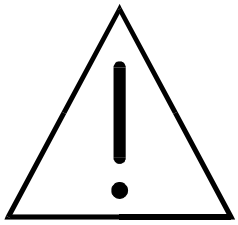
A suitable sample bag (3 liters or 5 liters Tedlar® bag, available as an accessory) is filled with the gas sample. The valve of the bag is closed (observe the instructions of the sample bag) and the bag is transported to the UT-3000 analyzer which has been set up at a safe place.



If flammable gases are filled into the sample bag extreme care has to be taken that the bag does not come into contact with hot surfaces, sparks, open fire etc. which could cause ignition of the bag. Severe physical or material damages could occur. Never use sample bags which are damaged or may leak ! It has also strictly to be avoided that air or oxygen can enter the sample bag. This could lead to the formation of an explosive gas mixture. The bag has to be emptied completely before filling with new sample. Do not store filled sample bags in badly aerated rooms. Empty the sample bag after use observing safety precautions for flammable gases.

FIGURE: CONNECTING A SAMPLE FILLED TEDLAR BAG TO THE UT-3000 SAMPLE INLET

8.3.1 Setup of the UT-3000 analyzer



Safety instructions – read carefully:
Place the UT-3000 onto a flat and dry surface (table). Take care that the ventilation holes on the bottom side of the analyzer are not covered by objects (like a sheet of paper, etc.) and air can free ventilate. This is important that in case of an internal leakage of the analyzer no explosive atmosphere can form inside the analyzer. During sample aspiration into the analyzer flammable gas will blow out from the gas outlet fitting on the rear side of the analyzer. Take care that the gas which comes out from this fitting is led to a well ventilated place without any ignition sources. It must be avoided that this gas can accumulate in closed volumes. If necessary use small tubing (ID 4 mm) to guide the gas away from the analyzer to a well ventilated place. Do not use a tubing which is longer than 5 meters to avoid accumulation of explosive gas inside the tubing.

It is a precondition that the instrument has been properly calibrated as described **in chapter 4**. The sample volume has to be set at a value which is smaller than the volume which has been filled into the sample bag.

Standard setting is 0.1 to 1 liter, depending on the expected concentration. For higher concentrations the sample volume has to be set smaller, for lower concentrations the sample volume should be higher, see table. To set the sample volume press F2 from the main menu (see also **chapter 3.4.1**).

Concentration range	Sample Volume	Cycle Duration
0.001 µg/m3 – 0.5 µg/m³	10.0 liter	17.5 min
0.002 µg/m³ - 1 µg/m³	5.0 liter	10 min
0.01 µg/m³ - 5 µg/m³	1.0 liter	4 min
0.02 µg/m³ - 10 µg/m³	0.5 liter	3.3 min
0.05 µg/m³ - 25 µg/m³	0.2 liter	3 min
0.1 µg/m³ - 50 µg/m³	0.1 liter	3 min
> 50 µg/m³	0.01 liter	3 min

TABLE: SAMPLE VOLUME SETTINGS FOR DIFFERENT CONCENTRATION RANGES

According to the composition of the sample gas the built-in flow meter is automatically calibrated before each measurement in order in order to achieve the correct sample volume.

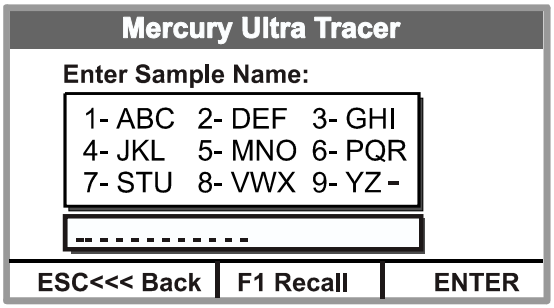
8.3.2 Sampling of natural gas with the sample bag (Tedlar® bag)

The sample bag has to be completely empty before filling with sample gas. This may be done by opening the valve of the bag, placing the bag onto a smooth and clean surface and running the back of the hand over the bag until it is totally flat. Filling must be done by connecting the sample bag with a source of positive pressure. Open the valve of the bag by turning its upper portion counter-clockwise one revolution. It has under all circumstances to be avoided that air can enter the sample bag because this could lead to formation of an explosive mixture in the sample bag. For this reason do not use a pump for filling the bag. Do not inflate the bag too much, avoid filling the bag more than 80 % of its maximum volume. Close the sample bag by turning the upper portion of the valve clockwise until it is snug. Observe operating instructions coming with the sample bags.

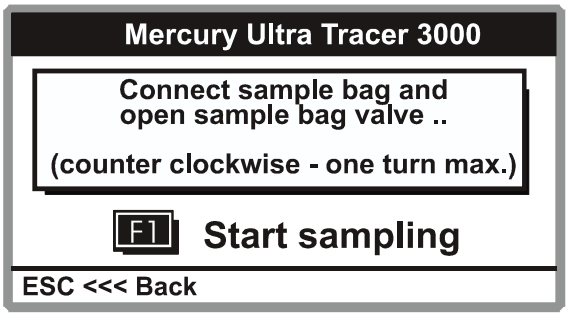
Transportation of the gas filled sample bag
Be careful when handling or carrying a filled bag as it contains flammable gas. It must be avoided that air can enter the bag. Use smaller bags (for example 3 litre bags) whenever possible to minimise risk. Keep the filled bag away from any ignition source.

8.3.3 Measuring the sample from the bag

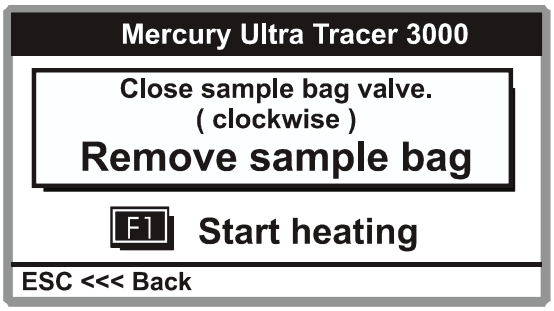
After the instrument has been switched on and warmed up the user is asked to enter the sample name. Use the numerical keys (0-9) to enter letters or numbers, use the left arrow button for delete or the up arrow buttons to move the cursor right. Enter letters first and press **ENT**, then enter numbers and press **ENT** if finished. With the **F1** key the previous sample name can be recalled.



A message on the display tells the operator to connect the sample bag and to open the sample bag valve. Place the sample bag in front of the analyzer on the same table. Connect **t**he sample bag to the sample gas inlet nozzle of the UT-3000 analyzer using the Tygon tubing which has been delivered with the instrument. The bag should be placed onto the same table where the analyzer is set in order to avoid that it may disconnect from the analyzer thus causing a leak. Now open the valve of the bag by turning its upper portion counter-clockwise one revolution.



Press **F1-Start sampling** to commence sample introduction into the analyzer. The instrument will draw the preset volume of sample from the bag.
After the sampling has been completed the sample bag valve must be closed.
The end of sampling is indicated by a beeping sound and the message: **Close sample bag valve (clockwise); Remove Sample Bag**. To close the sample bag turn the upper portion of the valve clockwise until it is snug. The bag must be removed immediately.
Now analysis has to be started by pressing **F1-Start heating**.



After ca. one minute (depending on sample volume) the result is displayed on the screen.
After analysis the sample bag should completely be emptied observing above safety instructions.

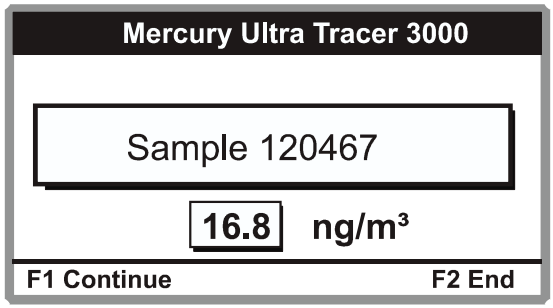


FIGURE: TEDLAR BAG VALVE WITH CONNECTING NOZZLE. OPEN AND CLOSE: HOLD THE LOWER PART WITH NOZZLE WITH ONE HAND AND TURN THE UPPER PART WITH THE OTHER HAND.

FIGURE: ATTACHING THE CONNECTION TUBING TO THE TEDLAR BAG NOZZLE

FIGURE: POSITION OF THE TEDLAR BAG DURING SAMPLING

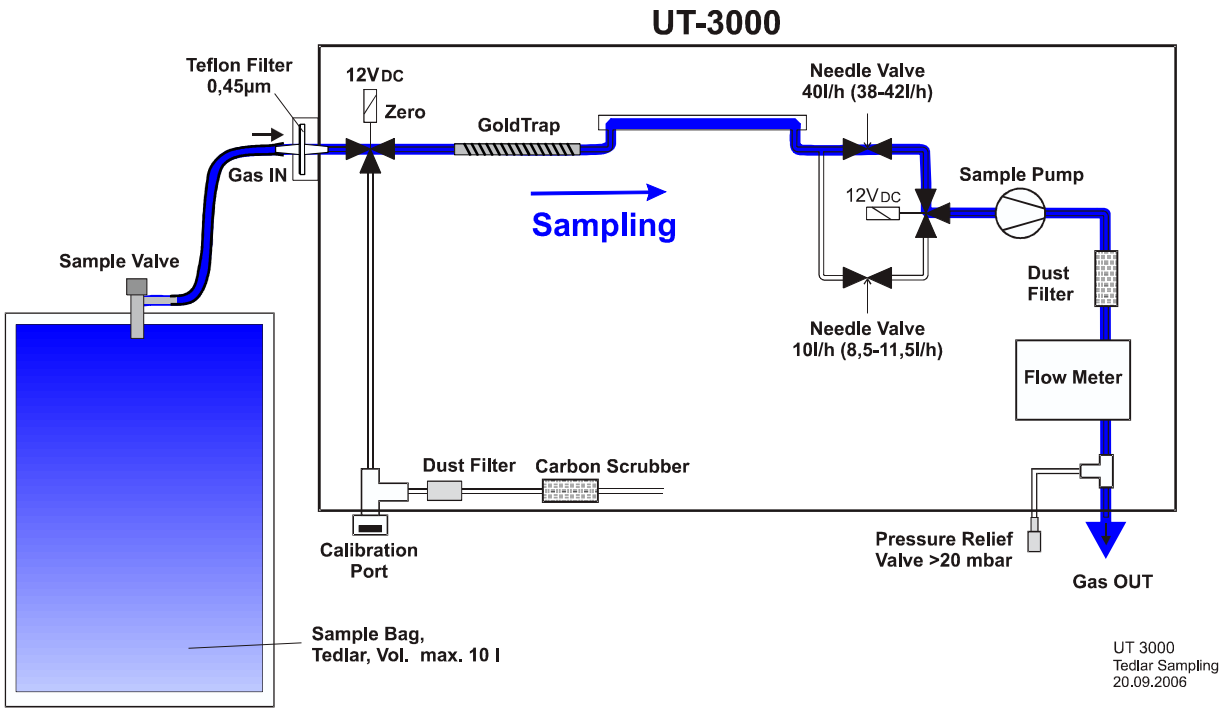


FIGURE: FLOW OF SAMPLE FROM TEDLAR BAG THROUGH ANALYZER DURING SAMPLING STEP

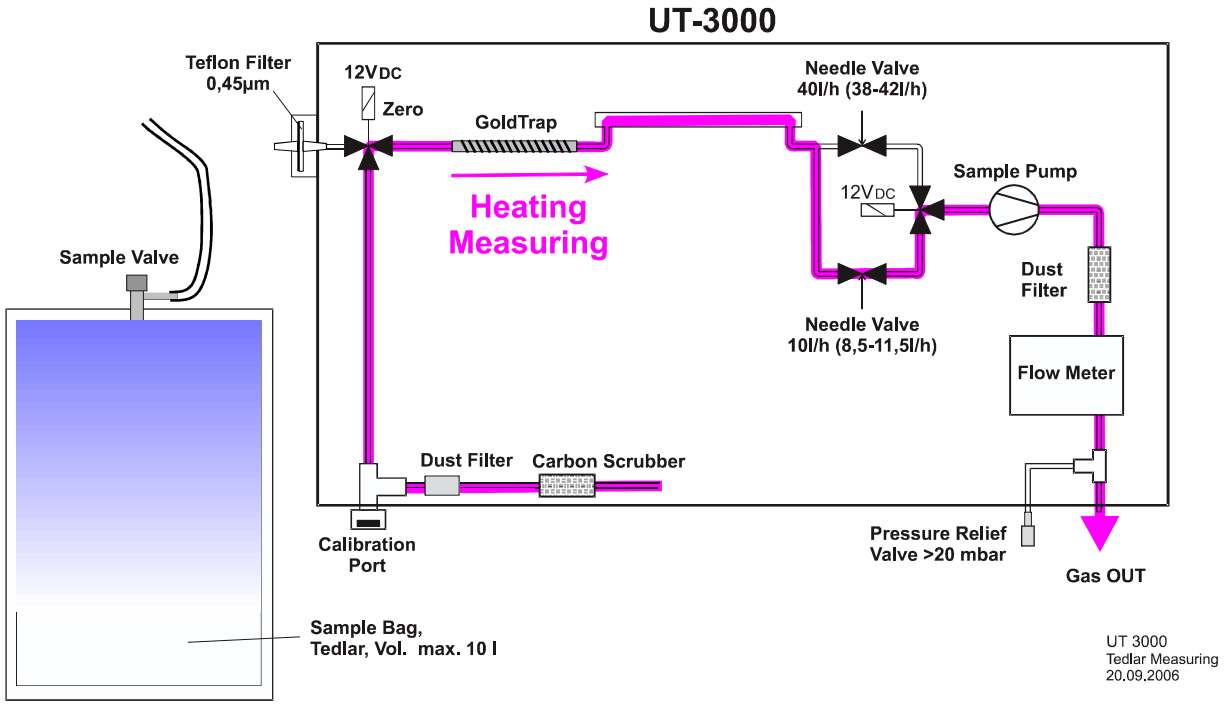


FIGURE: FLOW OF CARRIER AIR AND DESORPTION OF MERCURY FROM GOLDTRAP HEATING/MEASURING STEP

8.4 Select Pump Type

The system can be equipped with two different pump types: a rotary vane pump or a membrane pump. According to the installed pump “rotary vane” or “membrane” has to be selected by pressing the **F3**-key in the service menu (3 2 1-code) on page 3.

Background information for service: if “membrane pump” has been selected as pump type, the “heating flow regulate” function in service menu 222 is void.

9. Communication with external data acquisition system (option)

The UT-3000 is prepared for connecting to an external data acquisition system. In this case the data acquisition system will be the master and the UT-3000 the slave. The master can send queries and commands. Results of measurements, calibration, and the set parameters can be read out, a zero check and a span check will be carried out on demand.

9.1 Parameter settings for remotely triggered zero and span check

In order to prepare the system for a remotely triggered zero check and span check the parameters shown in the table below have to be set.

Parameter	**Value**
Service Code 777	Automatic Calibration Module ON
Service Code 999	F2- Span Calibration activated
Span Calibration Menu	Time Interval for Span Check: 0

9.2 UT- 3000 external data access *(version 04.05.2004)*

Parameters, status and logger data can be transferred to an external master via the USB/RS232 port.
The UT-3000 software controls this port port regularly and in the case of an inquiry the data are transmitted immediately.
The actual cycle of the UT-3000 is generally not interrupted during data handling and has priority.
The actual measurement cycle will be terminated if a span check or zero check command is sent to the UT-3000.

☞ External transmission and data handling is only possible, when the UT-3000 is in the automatic measuring mode. Otherwise the USB/RS232-port is not controlled.

RS232 parameter setting: 38 400 baud, 8 data bits, 1 stop bit, no parity

All data are ASCII-Characters, between the characters is a semicolon (;)

Telegram for inquiry and transfer (without logger data transfer):

<STX>;command type; command ;<CRC>;<ETX>

<STX>	1 Byte	Start of text (02Hex)
;	1 Byte	separator semicolon
command type	1 Byte	inquiry logger or status or parameter or system control
command	1 Byte	
<CRC>	5 Byte	Checksum CRC16, max. 5 bytes
<ETX>	1 Byte	End of text (03Hex)

If the checksum is wrong, the UT-3000 answers:

<STX>;E;13827;<ETX> 13827 = CRC16
E= error command
valid for every checksum-error

If the external master recognises a checksum-error, the master has to repeat the inquiry, not to send the error command to the UT-3000.
If the UT-3000 does not recognise the command or an unknown command is send,
the UT-3000 answers:

<STX>;X;26122;<ETX> 26122 = CRC16

Type of command:	**L:**	logger, read, reset
	S:	status
	P:	inquiry of parameters
	C:	system control

Logger Command:

Inquiry: <STX>;L;S;<CRC>;<ETX> external inquiry for logger status

Answer: <STX>;L;0;<CRC>;<ETX> 0 = Logger off

<STX>;L;1;A;B;C;<CRC>;<ETX> 1 = Logger on
A = start date, 6 bytes (year, month, day)
B = start time, 4 bytes (hour, minute)
C = number of logged data
5 bytes (max. 5000 data records)
data no 1 = first registered data

Example: *<STX>;L;S;23038;<ETX>* *23038 = CRC16*
<STX>;L;0;43478;<ETX> *43478 = CRC16*
<STX>;L;1;040228;1530;123;23598;<ETX> *date = 28.02.04*
time = 15:30
number of logged data = 123

Inquiry: <STX>;L;R;<CRC>;<ETX> command to reset the logger

Answer: <STX>;L;R;<CRC>;<ETX> same as the inquiry

Example: *<STX>;L;R;51711;<ETX>* *51711 = CRC16*

Inquiry: <STX>;L;D;index;<CRC>;<ETX> index = number of data records, max. 4 bytes

Answer: <STX>;L;date;time;sample volume;concentration;<CRC>;<ETX>
one data record is transferred = logger data transfer
date = day, month, year (6 bytes)
time = hours, min. (4 bytes)
sample volume (max. 5 bytes)
concentration (max. 6 bytes)

Example: *<STX>;L;D;23;20443;<ETX>* *23 = no. of data record*
<STX>;L;280204;1630;2.0;2.3;58784;<ETX> *date = 28.02.04*
time = 16:30
sample volume = 2.0
concentration = 2.3

Status Command:

Inquiry: <STX>;S;<CRC>;<ETX> S = system status

Answer: <STX>;S; letter 1;letter 2;<CRC>;<ETX>

Letter 1:
H = Heating
C = Calibration
S = Sampling
O = Cooling
Z = Zero
E = Evaluation
X = unknown status

Letter 2:
O = OK, no error message at the display
L = „Lamp“ at the display
P = „Pump“ at the display
T = „Temp“ at the display (temp of calibration cell)

Example: *<STX>;S;22029;<ETX>* *22029 = CRC16*
<STX>;S;H;O;13041;<ETX> *13041 = CRC16*
H = Heating
O = no error

Parameters Command:

Inquiry: <STX>;P;letter;<CRC>;<ETX> P = parameters

Letter:
M = actuel mode (answer: V = volume mode; T = time mode)
H = operating hours
L = lamp voltage
T = temperature of calibration cell (°C)
K = calibration-mode (answer: E = single cal.; A = auto cal.)
I = automatic calibration interval or calibration unit
D = date and time of the last calibration
C = data of the calibration curve (equation, const., correlation coefficient)
V = last concentration with date and time

Answer: <STX>;P;number;<CRC>;<ETX> number: according value or
E, A or
V, T or
P= pg or
U= µl when manual calibration has been chosen or date, time, calibration data

Example: *<STX>;P;M;27120;<ETX>* *27120 = CRC16*
<STX>;P;V;39418;<ETX> *V = volume mode*

<STX>;P;H;14835;<ETX>
<STX>;P;32;57166;<ETX> *operating hours = 32*

<STX>;P;L;63985;<ETX>
<STX>;P;3.2;29145;<ETX> *lamp voltage = 3.2 V*

<STX>;P;T;63995;<ETX>

<STX>;P;19.2;43850;<ETX> *temp. of calibration cell = 19.2 °C*

<STX>;P;K;51699;<ETX>
<STX>;P;E;43511;<ETX> *E = single (manual) calibration*

<STX>;P;I;43506;<ETX>
<STX>;P;U;27130;<ETX> *U = µl (when manual calibration has been chosen)*
<STX>;P;P;14841;<ETX> *P = pg (when manual calibration has been chosen)*
<STX>;P;4;63955;<ETX> *calibration. interval = 4 hours (when Auto. Calibration has been chosen)*
<STX>;P;1130;44505;<ETX> *start time of calibration. = 11:30 (when auto calibration. Has been chosen)*

<STX>;P;D;14838;<ETX>
<STX>;P;280204;1250;56724;<ETX> *date = 28.02.04*
time = 12:50 (of last calibration)

<STX>;P;C;2548;<ETX>
<STX>;P;1.23456789;2.34567;3.45678;10851;<ETX> *calibr. Data (equation; const; correlation coefficient)*

<STX>;P;V;39418;<ETX>
<STX>;P;1.2;280204;1040;708;<ETX> *last concentration = 1.2, date = 28.02.04, time= 10:40*

System control command:

Inquiry:	<STX>;C;S;<CRC>;<ETX>	C = control S = start span-check
Answer:	<STX>;C;S;<CRC>;<ETX>	span-check will be started
Example:	<STX>;C;S;19965;<ETX> <STX>;C;S;19965;<ETX>	19965 = CRC16 span-check will be started
Inquiry:	<STX>;C;S;V;<CRC>;<ETX>	C = control S = span-check V = value (= read span-check value)
Answer:	<STX>;C;V;conc;<CRC>;<ETX>	V = value conc = meas. concentration in ng/m³
Example:	<STX>;C;S;V;55038;<ETX> <STX>;C;V;1.3;14490;<ETX>	55038 = CRC16 14490 = CRC16 1.3 = concentration
Inquiry:	<STX>;C;Z;<CRC>;<ETX>	C = control Z = start zero-check (sample volume= 1litre)
Answer:	<STX>;C;Z;<CRC>;<ETX>	zero-check will be started
Example:	<STX>;C;Z;7675;<ETX> <STX>;C;Z;7675;<ETX>	7675 = CRC16 zero-check will be started

Inquiry:	<STX>;C;Z;V;<CRC>;<ETX>	C = control Z = zero-check V = value (= read zero-check value)
Answer:	<STX>;C;V;conc;<CRC>;<ETX>	V = value conc = meas. Concentration in ng/m³
Example:	<STX>;C;Z;V;19197;<ETX> <STX>;C;V;1.1;22683;<ETX>	19197 = CRC16 22683 = CRC16 1.1 = concentration
Inquiry:	<STX>;C;C;<CRC>;<ETX>	C = control C = continue sampling
Answer:	<STX>;C;C;<CRC>;<ETX>	continue sampling
Example:	<STX>;C;C;36336;<ETX> <STX>;C;C;36336;<ETX>	36336 = CRC16 continue sampling

For span check and zero check the „rising time“ and the „falling time“ have to be considered. The „rising time“ and the „falling time“ according to the set sample volume of the UT3000 are shown in the table below.

In the following the maximum times are shown:

ZERO:

Sample volume:	**rising time**	**falling time**	**first sample reading after zero check**
0.1 l	425 sec.	331 sec.	161 sec.
1 l	275 sec.	262 sec.	242 sec.
2 l	275 sec.	352 sec.	332 sec.
3 l	275 sec.	442 sec.	422 sec.
10 l	275 sec	532 sec	1052 sec.

SPAN:

Sample volume:	**rising time**	**falling time**	**first sample reading after span check**
0.1 l	1672 sec.	331 sec	935 sec.
1 l	1522 sec.	262 sec.	1016 sec.
2 l	1522 sec.	352 sec.	1106 sec.
3 l	1522 sec.	442 sec.	1196 sec.
10 l	1522 sec.	532 sec.	1826 sec.

INDEX

accessories 55
Applications 7
Auto Range 19
automatic calibration 43
Automatic Calibration Unit
  connection 14
bag sampling 84
calibration
  automatic 43
  manually 32
Calibration Data
  Set 51
connection
  Automatic Calibration Unit 14
  data output 11
  electrical 11
  RS232 11
Data Logger
  send data to PC (Hg-Transfer) 26
Declaration of Conformity 97
desiccant cartridge
  replacement 69
Device Data 50
dryer tube
  replacement 69
EC-Declaration 97
error messages 64
filter
  replacement of 68
filter cartridges
  replacement 68
flammable gas
  safety instructions 85
flammable gases 84
flow
  show 50
Flow
  adjustment 75, 76
fuses 70
gas flow
  schematic 81
GoldTrap
  Cleaning 71
  replacement 71
Heating Flow
  Adjustment 75
installation 10
main menu 15
maintenance 55
measuring
  start 19
Measuring principle 9
membrane filter
  replacement 68
natural gas 80
  sampling system 80
parts list
  Automatic Calib Unit 62
  UT-3000 58
power supply 11
principle
  of measurement 9
print function 16
Purge Repetitions 50
Repeat Zero 54
replacement
  filter cartridges 68
Safety 2
Safety instructions
  flammable gas 85
sample bag 84
sample volume
  set 17
Sampling Flow
  Adjustment 75
Service Codes 54
service menu 49
set
  date and time 50
Set
  Calibration Data 51
  cycle duration 18
  sample volume 17
Settings
  basic 17
show flow 50
spare parts 55
specifications 78
Static Calibration Set 36
storage 79
syringe positioning 51
Tedlar bag 84, 90
transport 79
Trap Counter 52
tubing
  ID numbers 59
turning on
  UT-3000 15
unpacking 10
Warnings 2

APPENDIX

EC-Declaration of Conformity

The Company: **Mercury Instruments GmbH**
Liebigstrasse 5
D-85757 Karlsfeld
Germany
Declares that the product: **UT-3000 Mercury Ultratracer**
Intended purpose: **Automatic measurement of mercury at trace concentration levels in air and other gases**

conforms with the basic requirements of the relevant EC directives.
A conformity assessment method as provided in the directives has been executed.

For verification in accordance with the directives 89/336/EEC, 73/23/EEC and the other relevant provisions the following harmonized standards were applied:
EN 61326 :1997+A1 :1998+A2 :2001
EN 55014-1 :2000+A1 :2001
(Tests: EN CISPR 15-1 :1993; CISPR 16-2 :1996 ; EN 61 000-4-6:1996 / ENV 50 204:1995,EN 61000-3-2:2000+ Corrigendum 1:2001; EN 61000-3-3:1995+ Corrigendum: 997+A1:2001)
EN 61326:1997+A1:1998+A2:2001
(Tests : EN 61000-4-2 :1995+A1 :2001; EN 61000-4-3 :2002 ; EN 61000-4-4 :1995+A1 :2001+A2 :2002; EN 61000-4-5 :1995+A1 :2001; EN61000-4-6 :1996+A1 :2001; EN 61000-4-11 :1994+A1 :2001)

The tests regarding above standards have been conducted by Intertek Deutschland GmbH, Kaufbeuren/Germany (Test Report Nr. 04KFE003157-01). The test documents are available for inspection.

This declaration is submitted by:

Karlsfeld, 18nd August, 2008 Dr. Alfred Sauerer

Intertek ETL SEMKO

Konformitätsbescheinigung

(Certificate of Conformity)

Niederspannungsrichtlinie 73/23/EWG

(Low Voltage – Directive 73/23/EEC)

Bescheinigungs-Nr.: *(Certificate no.)*	**04KFA1513-01**
Bescheinigungsinhaber: *(Certificate Holder)*	**IMT Innovative Messtechnik GmbH** **Strehbergweg 11** **92709 Moosbach** **Germany**
Fertigungsstätte: *(Manufacturing Site)*	**Mercury Instruments GmbH** **Liebigstr. 11b** **85757 Karlsfeld** **Germany**
Produkt:	**Gerät zum Messen von Quecksilberkonzentrationen in der Luft oder anderen gasförmigen Proben**
(Product)	**Device for measurement of mercury concentrations in air and other gaseous samples.**
Typbezeichnung (Type):	**Mercury Ultratracer UT- 3000**
Markenname: *(Brandname)*	—
Beschreibung: *(Description)*	**230 V, 50 Hz; Schutzklasse I (Class I)** **UT - 250VA, Calibration Unit – 70VA**
Prüfbericht Nr.: *(Test report no.)*	**04KFI003283 : 2004-05-24**
Geprüft nach: *(Tested according to)*	**EN 61010-1:2001** **IEC 61010-1:2001**
Ergebnis: *(Result)*	**Die Geräte erfüllen die Anforderungen der genannten Normen.** The equipment fullfills the requirements of the above mentioned standards.
Erstellt am (issued on):	**2004-08-04**

Intertek Deutschland GmbH

Intertek Deutschland GmbH
Dipl.-Ing. Roland Heine

Dem Zertifikat liegen die Allgemeinen Geschäftsbedingungen der Intertek Deutschland GmbH zu Grunde.
The General Business Conditions of Intertek Deutschland GmbH is an integral part of this certificate.

Intertek Deutschland GmbH, Nikolaus-Otto-Str. 13, 70771 Leinfelden-Echterdingen
Sitz Leinfelden-Echterdingen, Registergericht Nürtingen, HRB Nr. 5262, Geschäftsführer Jörg-Timm Kiksch, Gosta Fredriksson